MEDRAD

MCT and MCT *Plus* Injection Systems

Service Manual

KMP 860P

Revision C

MCT and MCT *Plus* SERVICE MANUAL

Table of Illustrations - *Line Art*

Table of Illustrations - *Drawings*

SECTION 2 - PREFACE

Copyright Notice

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Restricted sale: Federal (USA) law restricts the sale of this device to, on, or by the order of a physician.

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Medrad reserves the right to change specifications and the contents of this manual without obligation.

External wiring modification disclaimer: Medrad cannot be liable for damage done by unauthorized interfaces or unauthorized modifications to the MCT / MCT *Plus*. Such unauthorized action could jeopardize injector operation, safety, or reliability. Medrad will review and, if appropriate, authorize modifications, repairs and special interfaces. To obtain this service, call or write to Medrad's Factory Service Department (address, phone and telex listed below).

All drawings in this manual are for reference purposes only, and may not reflect the construction of units produced prior to the publication of this manual. Reproduction quality of these drawings may have been effected by the level of reduction required. Call Medrad Factory Service if assistance in drawing interpretation is required.

Effectivity

This manual applies to the MCT and MCT *Plus* Injection Systems in the following configurations: Control Room Console MCT 305/310, and MCT 305P/310P, Remote Panel Systems RPS 350 and 350P.

Injection Systems equipped to operate at voltage requirements of 95-125 VAC, will be designated throughout this manual as -1 units. Injection Systems equipped to operate at voltage requirements of 190-250 VAC, will be designated throughout this manual as -2 units.

If you have any comments on this manual, please call or send the details to:

Technical Support Department
MEDRAD, INC.
P.O. Box 780
Indianola, PA 15051-0780

(412) 967-9700
1-800-MEDRAD-1
(1-800-633-7231)
TLX: 199114
FAX: (412) 963-0859 USA

If you encounter technical problems with the MCT or MCT Plus Unit or want to order parts, contact your local dealer, or:

Domestic:

Medrad Factory Service
MEDRAD, INC.
240 Alpha Drive
Pittsburgh, PA 15238-2870
(412) 967-9700
1-800-MEDRAD-S
1-800-633-7237
TELEX: 199114
FAX: (412) 963-1964

International:

MEDRAD INTERNATIONAL, B.V.
Postbus 3084
6202 NA Maastricht
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Phone: (31) (0) 43 640808
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Preface

ABOUT THIS MANUAL

Purpose
This is the Service Manual for MCT and MCT *Plus* CT Injection Systems. This manual is intended to provide instructions for servicing the injectors as safely and thoroughly as possible.

Important Safety Notice
The information in this manual is intended for people with adequate backgrounds and experience in electronics and electromechanical devices. Any attempt to repair a sophisticated medical device such as the injector may result in personal injury, property damage, or patient injury. Medrad and other distributors of the injector cannot be responsible for the interpretation of this information, nor can they assume any liability in connection with its use.

Intended purpose of the MCT/MCT *Plus* Injector
This device is sold for the specific purpose of injecting contrast medium into humans and animals for diagnostic studies. Do not attempt to use the injector for any other purpose such as chemotherapy or drug infusion.

Audience
This manual is written for those qualified to service the injector, whether they be Medrad Service Personnel, Laboratory Service Technicians, or Medrad International Dealers.

Software
The information in this operation manual applies only to MCT and MCT Plus CT Injectors equipped with software version CU2.1 or below, and Remote Panel software version EP2.0 or below.

MCT *Plus* units designed as Class 1 Type BF equipment and are identified throughout this manual as -I units.
MCT *Plus* rack mount units manufactured after July 30, 1991, equipped to operate at 220-250 VAC, are designed to, and in compliance with, RF emission standard for Class 1 Type BF equipment, and meet IEC Standard 601-1 for Class 1 Type BF equipment. Class 1 Type BF equipment is identified by the following symbol:

WARNINGS and CAUTIONS

PLEASE READ CAREFULLY

WARNINGS:

Ensure that FluiDot Labels are present and clearly visible on all pressure jackets on non-Front Load Systems. FluiDot labels are intended to help avoid air embolization, and should be clearly visible on the pressure jacket.

Hazardous voltages exist within the MCT/MCT *Plus*. To avoid shock, the injector should only be opened by qualified service personnel. Always disconnect the injector from line power before cleaning or attempting to perform any maintenance.

Possible explosion hazard. Do not use the MCT/MCT *Plus* in the presence of flammable anesthetics.

Do not use the injector if a system monitor message is displayed. System monitor messages are displayed on the Control Panel, and are preceded by "SC". This type of message indicates serious system malfunctions. Do not use the injector until the cause of these messages can be determined. Contact a Medrad Factory Service Representative for assistance.

Do not use the injector if any worn cords or cables are detected. Personal Injury or equipment damage/malfunction may result. Contact the Medrad Factory Service Department for replacement information.

Check for proper voltage and frequency before plugging the injector into an electrical outlet. Check the voltage and frequency marked on the serial number tag on the back of the injector. Typical markings are 110 VAC 60 Hz or 220 VAC 50 Hz. Be sure that the outlet providing power to the injector supplies this voltage and frequency. Personal injury or equipment damage/malfunction may result.

Do not apply voltage to external start lines. If the injector is being started by an external start connection, do not apply voltage to the start circuit. Provide only a switch closure. If the external circuit contains excessive line frequency noise or transients, personal injury or equipment damage/malfunction may result.

Use remote disarm switch with external starts. If the injector is wired to be started externally, the operator does not have full control of the injector with the standard handswitch. The handswitch may be used to start the injector as normal, but once the external start contacts are closed, releasing the handswitch may not abort the injection. Therefore, we suggest providing an external disarm switch if an external start circuit is used. However, any injection may be aborted by pressing a Control Panel key.

Possible injury to the patient and technician can occure if the injector head stand is moved by pulling on the injector head. This practice will cause the pivot pin the wear and may cause the injector head to fall.

Do not position the system by pulling on the injector head or cabling if using an Overhead Counterpoise System. If the "Head Mount Knob" is not tight and the user pushes up on the head to raise the system to its highest position, the potential exists for the injector head to lift out of its socket and fall. This could cause user or patient injury. Use the Overhead Counterpoise "Vertical Support Arm Assembly" to move and position the head. Also, ensure that the "Head Mount Knob" which secures the injector head to the Vertical Support Arm is tight at all times. Refer to the Overhead Counterpoise System Operation, Installation and Service Manuals for additional Warning and Caution information.

CAUTIONS:

Electrostatic Discharge (ESD). Static protection practices must be followed when servicing any component of this system. Before touching any of the circuit cards in the injector, discharge yourself to grounded metal. If the memory chips are to be shipped, place the components in conductive carriers (such as that used by Medrad).

Do not short PPI Card batteries. When handling the PPI Card, or when measuring or replacing the batteries on the PPI Card, be careful not to short the batteries, which can be damaged by even a momentary short. Do not set the card on any metal surface; this will short out the connections on the bottom of the card, and discharge the batteries.

Do not remove or replace circuit boards with power applied to the injector. Sensitive circuits on the cards can be damaged by abrupt interruption or application of supplies. Remove power before servicing.

Total length of the head extension cable should not exceed 100 feet (30.5 m). If cables are connected in series *or* their total length exceeds 100 feet (30.5 m), injector performance and specifications will be adversely affected.

CAUTION: Do not manually advance the piston plunger if the injector is armed. If the standard procedure is to manually move the piston plunger to ensure that no air is in the connector tube perform this step before arming. Movement of the plunger up to 2 ml in the forward or reverse direction after the injector is armed will result in an inaccurate volume delivery. The injection bolus volume will be program volume minus the preliminary plunger movement. (i.e.., If program volume is 10 ml and the plunger is advanced 2 ml while the injector is armed, the actual volume delivered to the patient during the injection will be 8 ml. This volume displacement will not be displayed when Status values are displayed.)

Allow injector temperature to stabilize before use. When the injector is exposed to an extreme temperatures change (heat or cold), allow it to stabilize to room temperature before servicing.

Use only accessories and options designed specifically for the MCT and MCT Plus. For proper operation, use only accessories and options provided by Medrad which are designed specifically for the MCT and MCT Plus system. This ensures compatibility with the injector. Do not use an accessory or option designed for another system on the MCT and MCT Plus.

Perform regular preventive maintenance. To ensure that your MCT/MCT Plus remains properly calibrated, and that all primary and backup circuits are functioning properly, yearly preventive maintenance is suggested. Annual preventive maintenance (offered in the US and Canada) is not covered by the new machine warranty. Contact your local Medrad Factory Service Representative for details.

VOLUME REMAINING Keys and Display

If Programmed Injection Volume exceeds the volume remaining in the syringe, the Insufficient Volume Light illuminates. Press the Insufficient Volume key to override, then proceed with arming sequence. The Insufficient Volume Light flashes, and the injector can be armed.

Volume Remaining - ml

Insufficient Volume Key

Insufficient Volume Light

FIRST PHASE Keys and Displays

The First Phase Block displays the programmed Flow Rate and Volume for the first phase of an injection. To change either of these values, use the respective arrow keys located below each display.

First Phase Flow Rate Display - ml/sec

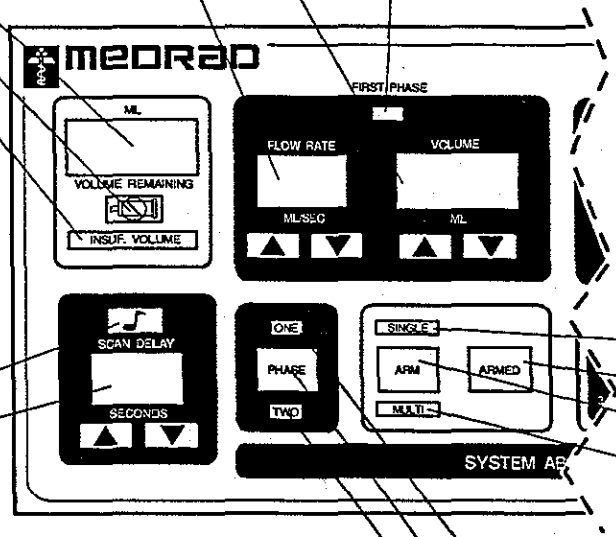
First Phase Volume Display - ml

First Phase Indicator

ARMED Keys and Displays

ARM:
Press the Arm key. The OP 100 message is displayed - **Confirm no air in fluid path.** If no air is detected, press the Arm key again. The Armed Indicator Light flashes, and the injector is armed for a Single injection.

MULTIPLE ARM:
To arm the MCT or MCT *Plus* for a multiple injection, press the Armed key while the injector is armed. The Multiple Injection indicator will light and the injector will remain armed after each injection as long as sufficient volume remains in the syringe.



SCAN DELAY Keys and Display

External scanning equipment can be delayed by entering a time value in the Scan Delay Window. Use the Scan Delay arrow keys to select a delay time - up to 99 seconds. The Scanner Tone Alert key is a toggle switch which activates a tone alarm whenever scanning begins.

Scanner Tone Alert Key

Scan Delay - Sec.

Single Injection Light

Armed Indicator Light

Arming Key

Multiple Injection Light

ARROW Keys

The arrow keys below the Scan Delay, Flow Rate, and Volume Displays all perform in a similar manner. To increase a value press the UP arrow key; to decrease a value press the DOWN arrow key. If any arrow key is held in for longer than 2 seconds, the value displayed will increase or decrease at 5 counts/second.

PHASE SELECTION Keys and Display

If a single phase injection is currently displayed it can be changed to a bi-phasic injection by pressing the Phase key. The Phase Indicator Lights change from ONE to TWO and values in the Second Phase block are displayed.

Single Phase Injection Light

Injection Phase Key

Bi-phasic Injection Light

PROGRAMMING Keys

Program Selection
- Press the Program Select key until the desired Program Number is lit
- Program Number 6 is used for Multi-Level programming

Program Change
- When any program is selected, change any programmed value with arrow keys
- Program Number light will flash left to right

Reprogramming
- Press Reprogram Key
- All values flash
- Change values with arrow keys

Program Store
- Press Program Lock key

Total Volume Programmed
- Press and hold Program Lock/Total Volume Programmed key when not reprogramming
- Total Volume Programmed will be displayed in Volume Delivered Window

SECOND PHASE Keys and Displays

The Second Phase Block displays the programmed Flow Rate and Volume for the second phase of an injection. Use the arrow keys to change the values displayed.

Second Phase Flow Rate Display - ml/sec

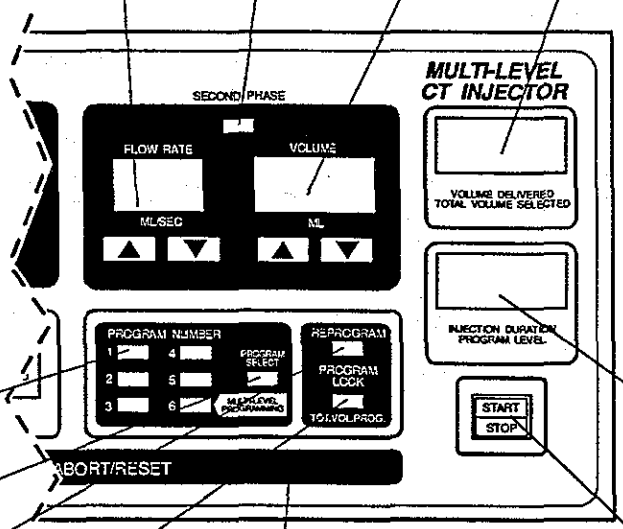
Second Phase Volume Display - ml

Second Phase Indicator

VOLUME DELIVERED and TOTAL VOLUME Window

The Volume Delivered Window displays the Total Volume Delivered in ml. This window also displays the Total Volume Selected. Press and hold the Program Lock key to check Total Volume Selected.

Volume Delivered - ml
or Total Volume Selected



INJECTION DURATION and PROGRAM LEVEL Window

This window displays Injection Duration. When a Multi-Level program is displayed, the Injection Duration window displays the current Program Level. While injecting, this window displays Injection Duration. While injecting in the multi-level mode, the PL number is briefly displayed.

Injection Duration
or Program Level

Program Numbers (1-6)

Program Select Key

Reprogram Key

Program Lock Key
or Total Volume Programmed

SYSTEM ABORT /RESET

The System Abort/Reset key is used to abort an injection, or reset the MCT after an OP message. When power is first applied, press and hold this key immediately after the countdown to display the version number of the software in your unit.

TO ABORT: PRESS ANY KEY.

START/STOP Key

Functions the same as the Hand Start Switch. When the MCT/MCT *Plus* is armed for a Single injection, use the Start/Stop key to begin the injection, or HOLD an injection during a procedure. If the injector is armed for Multiple injections, HOLD feature is disabled.

OP 100 CHECK SYRINGE FOR AIR, THEN ARM

This message is displayed after arming the unit for an injection. It is intended to remind the operator about the dangers of injecting an air embolism. Check the syringe and connector tubing for air, then press the ARM key again to proceed.

OP 101 UNIT DISARMED (applies to integral or remote panel keyboard)

An error condition has occurred after the unit was armed. Three conditions that may have caused this message are: forward or reverse load button on Injector Head was activated, a key on MCT / MCT *Plus* panel, (other than START/STOP), was pressed, or syringe turret was moved out of the injection position (non-Front Load systems only). Press the SYSTEM ABORT/RESET bar to continue.

OP 102 CHECK TURRET, THEN RESET (Non-Front Load injector heads only)

Turret is not in position for an injection. Re-position the turret, press the SYSTEM ABORT/RESET bar, then re-arm the unit.

OP 102 MECHANICAL STOP PLATE IMPACTED, MANUALLY REVERSE PLUNGER

(Front Load injector heads only) If the Mechanical Stop microswitch is activated before the injector is armed, this message code will appear. Press the SYSTEM ABORT/RESET bar, then use the manual knob to reverse the plunger to continue.

OP 103 FORWARD MOTOR MOVEMENT

After the unit was armed, the manual load knob on the Injector head was moved in the forward direction. Press SYSTEM ABORT/RESET bar to continue.

OP 104 REVERSE MOTOR MOVEMENT

After the unit was armed, the manual load knob on the Injector head was moved in the reverse direction. Press SYSTEM ABORT/RESET bar to continue.

OP 105 REMOTE CONTROL PANEL COILED START SWITCH SHORTED

This message alerts the operator that the Remote Control Panel Coil Start Switch was depressed or held down prior to or during the arming sequence. Press the SYSTEM ABORT/RESET bar then re-arm.

OP 106 MAIN UNIT START SWITCH SHORTED

This message indicates a Start Switch or Coiled Start Switch at the main control unit is depressed during the arming sequence. OP 106 does NOT apply to the Control Panel START/STOP button. Un-short the switch, press the SYSTEM ABORT/RESET bar, then re-arm.

OP 107 CHECK INJECTOR HEAD CABLE (PLUNGER)

The feedback signal from the plunger positioning potentiometer is not within allowable limits. Check cable connection J21 on back of MCT / MCT Plus main console for a secure and true connection. Press the SYSTEM ABORT/RESET bar and re-arm the MCT / MCT *Plus*.

OP 108 STALL TIME EXCEEDED

Some obstruction has stopped the plunger in its course of movement. If this condition persists longer than 3 seconds, the OP 108 message code is displayed. Check connector tubing for blockages, sharp bends, or kinks. If stopcocks were used ensure they are opened. Make sure the plunger path is free from obstacles. Press the SYSTEM ABORT/RESET bar to proceed.

OP 109 EXTERNAL EQUIPMENT DISARMING THE INJECTOR

The Imaging System Interface has signaled a problem, thereby rendering the MCT / MCT *Plus* Injector incapable of being armed. Determine which piece of external equipment is causing the problem, correct it, and press the SYSTEM ABORT/ RESET bar to proceed.

OP 110 INSUFFICIENT VOLUME REMAINING IN THE SYRINGE

Indicates to operator that the programmed volume of the current injection exceeds the actual volume remaining in the syringe. Press the SYSTEM ABORT/RESET bar to erase OP 110 message. Notice the lighted Insufficient Volume indicator in the Volume Remaining area of the MCT / MCT *Plus* panel. To override the arming lockout and avoid the OP 110 message, press the Syringe key just above the Insufficient Volume indicator. This causes the Insufficient Volume light to flash. The unit can now be armed.

OP 111 FORWARD/REVERSE LOAD SWITCH DEPRESSED

Indicates that the forward or reverse load button on the Injector Head was being pressed while the system was being armed. Release the forward or reverse load button, press the SYSTEM ABORT/RESET bar, and repeat the MCT / MCT *Plus* arming sequence.

OP 112 CHECK INJECTOR HEAD CABLE (MECHANICAL STOP)

The feedback signal from the mechanical stop positioning potentiometer is not within allowable limits. Make sure the cable connecting the Injector Head to the main console is connected securely. Press the SYSTEM ABORT/RESET bar to continue.

OP 113 *(MESSAGE NOT USED)*

OP 114 IMAGING SYSTEM INTERFACE, START COMMAND ACTIVATED

This message appears when an external device attempts to activate the injector prior to completion of the arming sequence. The external device is connected to J20 or J40 on the back of MCT / MCT *Plus* Main Console. Check for a secure cable connection. Press the SYSTEM ABORT/RESET bar to clear message.

OP 115 HOLD TIME EXCEEDED

The MCT / MCT *Plus* Injector has remained in the "Hold" mode for longer than 5 minutes. To avoid this problem, the operator must resume a held injection before 5 minutes elapse. Press the SYSTEM ABORT/RESET bar to proceed.

OP 116 PREMATURE START SWITCH RELEASE

Whenever the START/STOP switch or external hand start switch is held in longer than 5 seconds to start the injection, it must be held in until the injection is complete. The OP 116 message is displayed if these conditions are not met. Press the SYSTEM ABORT/RESET bar to clear the message, then repeat normal MCT / MCT *Plus* arming sequence.

OP 117 MOVE PLUNGER 2ML BEFORE ARMING

This message was added in software version 1.4 and above as part of additional self-diagnostic tests the MCT / MCT *Plus* performs when power is first applied. In order to check the circuitry monitoring plunger movement - the plunger must be moved. Normally, this requirement is fulfilled when the syringe is loaded and this message is not displayed. However, if power is interrupted between procedures and an attempt is made to re-arm the unit before the plunger has been moved, the OP 117 message is displayed. Move the plunger a minimum 2 ml FWD or REV before proceeding.

SECTION 4 - PREVENTIVE MAINTENANCE

This section contains recommended procedures for preventive maintenance of MCT and MCT *Plus* injection systems in the following configurations: Control Room Console MCT 305/310, and MCT 305P/310P, Remote Panel Systems RPS 350 and 350P. Following these simple procedures can:

- Ensure the best performance from your injector.
- Help avoid major problems though regular inspections and checkout.

Recommended Preventive Maintenance

Preventive maintenance of the injection system should consist of four procedures: Inspection, cleaning, performance checks, and electrical leakage checks. This section contains guidelines, recommended methods, and expected results for each of these procedures:

1. *Inspection:* This first step should encompass inspection of the entire system, looking for obvious signs of damage, such as; cracks in the housing, frayed or worn cords, and contrast spills that may have leaked into the injector.

2. *Cleaning:* This cleaning procedure involves thorough cleaning of the console and head to remove any deposits of contrast medium. If any substances have leaked into any part of the unit, the subassembly should be disassembled and thoroughly cleaned.

3. *Performance Check:* A complete functional performance checkout of the injection system.

4. *Electrical Leakage Check:* To insure the safety of the patient and hospital personnel in injector operations, an electrical leakage check is part of this preventive maintenance procedure.

Recommended Preventive Maintenance Schedule

Although Medrad recommends the following schedule, your individual maintenance schedule depends upon how your injector is used; the type of procedures performed, and frequency of use. The following guidelines represent a suggested maintenance schedule:

Monthly:

Once a month, the system should be inspected and cleaned thoroughly.

Semi-Annually:

Every six months, both the Electrical Leakage and Performance Checks should be performed.

NOTE: Local regulations or hospital protocol may **require** electrical leakage checks at *more frequent* intervals.

If this applies, local regulations for leakage tests must be followed.

Annually:

Medrad recommends that a complete system calibration and performance checkout, by a qualified Medrad Service Representative, be performed once a year. Contact your local Medrad office for details.

In the United States and Canada, the Medrad Service Department offers Preventive Maintenance Programs. These annual programs greatly assist in the maintaining of the accuracy and reliability of the unit, and can extend the life of the injection system. Contact Medrad for details. For information in Europe, contact Medrad International B.V.. Refer to Section 2 for address and telephone numbers

Inspection Procedures

The following procedures are recommended for the Injector Head, Control Unit, Remote Panel (if the system is so equipped), and mounting systems.

If defects are detected, either repair the system, or call Medrad for service. Do not use the unit until the problem has been corrected.

Injector Head Inspection

1. Inspect the injector head case for any cracks that could allow fluid to leak inside, or weaken the case.
2. Inspect the injector head cable for cuts, cracks, or worn areas.
3. Inspect the injector head connector for cracks, loose pins, or a loose strain relief.
4. If applicable, inspect the Pressure Jackets for small cracks, crazing, or discoloration. As a matter of preventive maintenance, we recommend replacement of the pressure jackets annually.
5. Inspect the syringe heater and cable; look for cuts, cracks, or any worn areas.
6. Inspect the Control Panel for cuts or cracks that could allow fluid to leak inside.

Control Unit Inspection

1. Inspect the Control Unit case for cracks that could allow fluid to leak inside, or weaken the case.
2. Inspect the power cord for cuts, cracks, or worn spots. Inspect the plug for cracks, loose prongs, loose wires, or a loose strain relief.
3. Inspect the handswitch and cord: Look for cuts, cracks, or worn spots in the cable; look for cracks and loose parts in the switch and housing.
4. Inspect the film changer connector and cord: Look for cuts, cracks, or worn spots in the cable; look for loose pins, or a loose strain relief on the connector.
5. Inspect any other cables connected to the control unit: Look for cuts, cracks, or worn spots in the cables; look for cracks, loose pins, or loose strain reliefs on the connectors.
6. Inspect the Control Panel for cuts or cracks that could allow fluid to leak inside.

Remote Panel Inspection

1. Inspect the remote unit case for cracks that could allow fluid to leak inside, or weaken the case.
2. Inspect the interface cable for cuts, cracks, or worn spots. Inspect the connector for cracks, loose prongs, or a loose strain relief.
3. Inspect the handswitch, cord, and connector: Look for cuts, cracks, or worn spots in the cable; look for cracks and loose parts in the switch, housing, and connector.
4. Inspect the Control Panel for cuts or cracks that could allow fluid to leak inside.

Mounting Systems Inspection

Pedestal Mount - ***KMA 320/KMA 320-T*** (See Figure 4.1)

- Inspect the stand, base, and support arm for cracks and other defects that could weaken the structure.
- Ensure that all mounting bolts and screws are secure.
- Ensure that the casters roll smoothly, with no binding or scraping.
- Ensure that the locking mechanism on all locking casters is functional.

Injector Support Arm

The injector head support arm is typically associated with the free standing injector head stand (KMA-320 or KMA-320T).

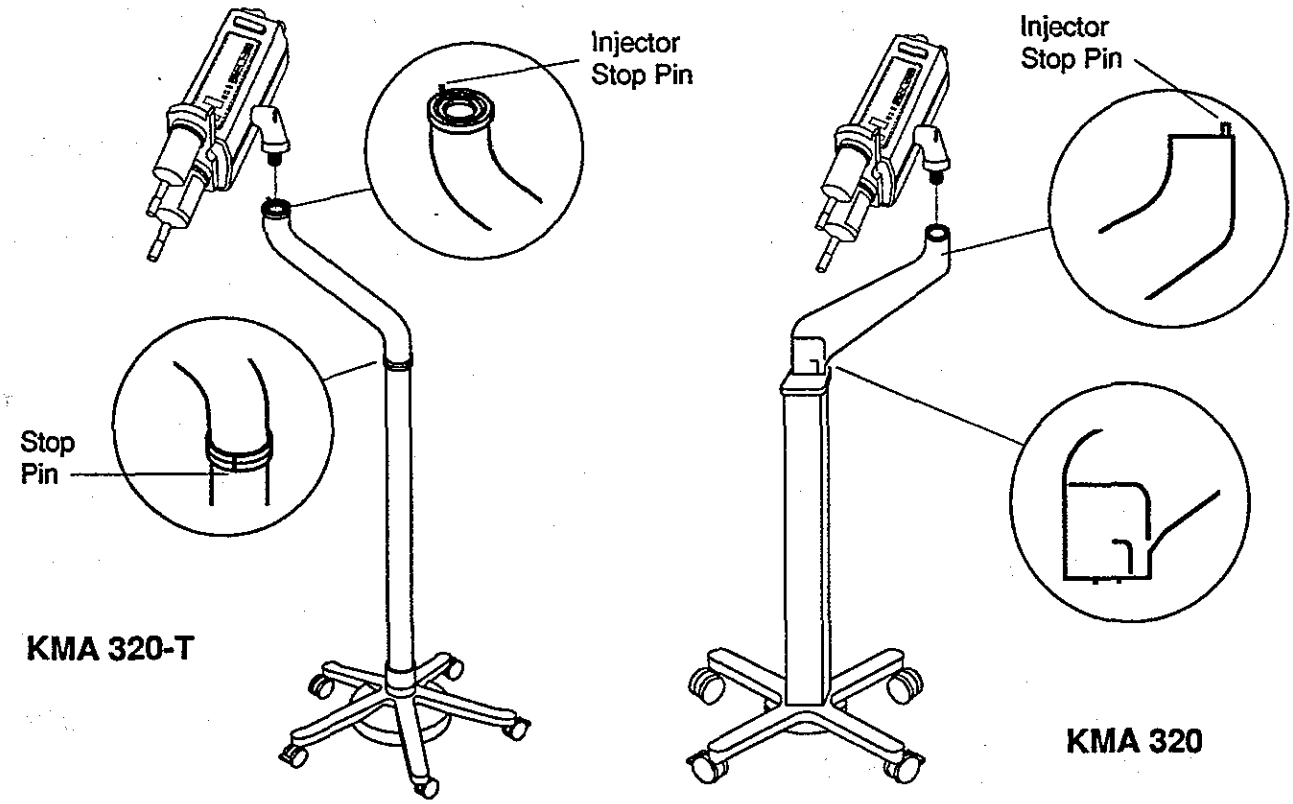


Figure 4.1: Head Support Arm Inspection Points

The injector head pivot knuckle should sit flat and rotate smoothly on the support arm. The injector head should not rotate more than 360 degrees. If the head is able to rotate more that 360 degrees, carefully lift the head from the support arm and check for the presence of the injector head stop pin. If the pin is not in place, the head cable can wrap around the arm causing damage to the head cable and possibly lifting the injector head off of the support arm.

Additionally, the support arm should be inspected for cracks where the head rests on the arm and at the base where it is attached to the injector head stand. If a crack is present, the crack can lengthen, compromising the integrity of the arm. If any cracks are found, Medrad Service should be contacted.

Overhead Counterpoise Systems, Wall and Ceiling Mount (See Figures 4.2 and 4.3)

Medrad provides both Ceiling and Wall mounted overhead counterpoise systems. Each system consists of an articulating vertical and horizontal arm that require regular maintenance inspections.

On a daily basis the black head mount knob should be checked to ensure that it is fully tightened. This knob is intended to secure the injector head on the vertical support arm and minimize the chance of the injector head being accidentally lifted from the support. Rotation of the injector head should be accomplished by turning the entire vertical support arm and not by rotating the injector head Additionally, the following items should be regularly inspected:

Long Pin and Spring Pin - (Figure 4.2) As a safety back up to the retaining clip, there is a long pin which passes through the vertical and horizontal support arm where they join. The through-hole at the bottom of the long pin should have a spring pin through it. The spring pin must be in place for the safety backup to be effective. On early OCS systems the long pin and spring pin will not be present. These early systems do not have a through hole for the long pin.

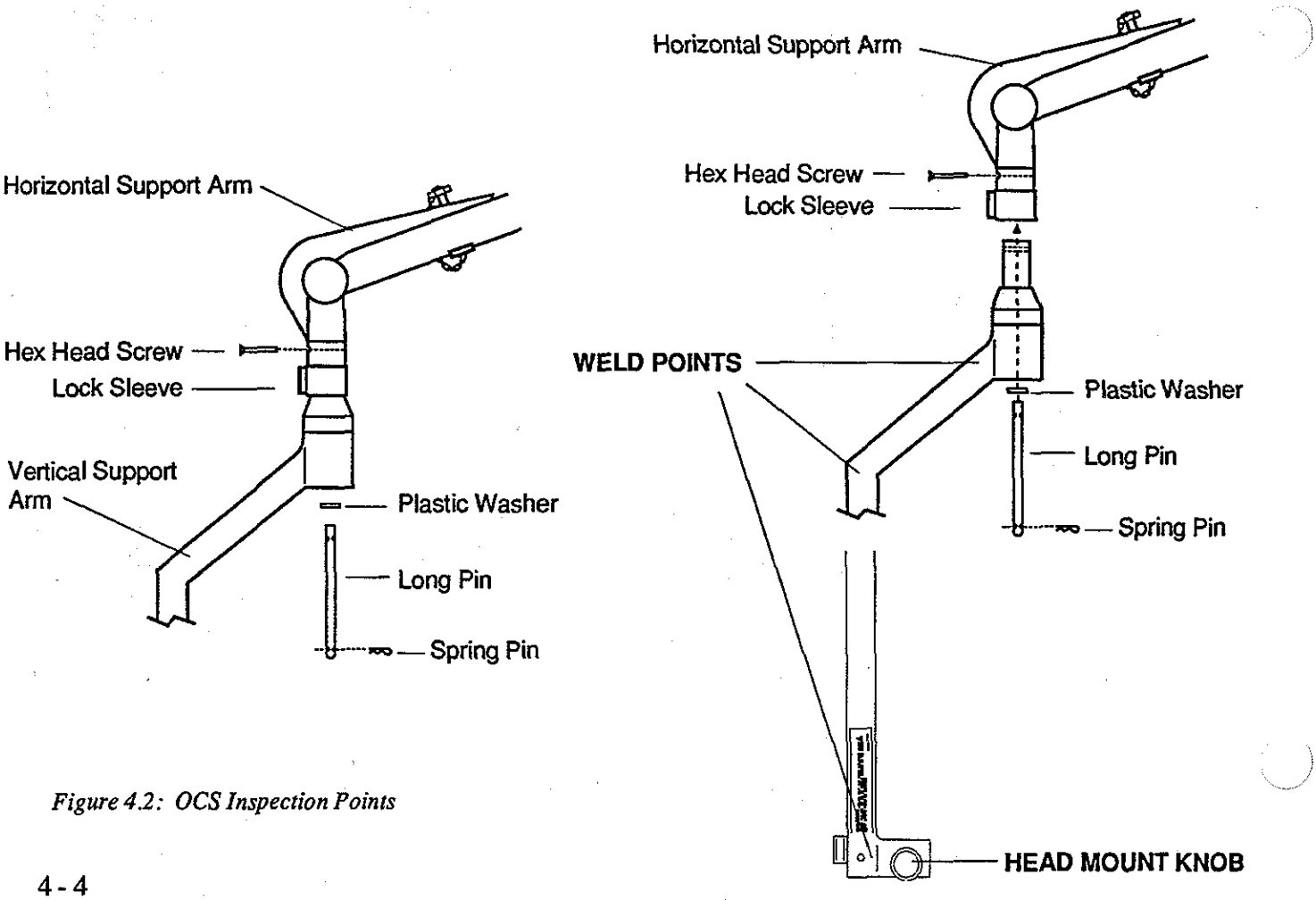


Figure 4.2: OCS Inspection Points

Vertical Support Arm - (Figure 4.2) The vertical support arm weld joints should be inspected for cracks. Cracks can lead to failure of the support arm.

Retaining Clip and Plastic Locking Sleeve - (Figure 4.3) The plastic lock sleeve should be inspected regularly to ensure it is not cracked or showing other signs of damage. It ensures the retainer clip remains in place. If the lock sleeve is missing or not in place, the retainer clip may come out resulting in the vertical arm releasing from the horizontal support. A damaged or missing plastic lock sleeve should be replaced immediately.

Horizontal Arm - (Figure 4.3) The horizontal arm should be inspected overall for cracks and any other loose or damaged parts. Any missing or damaged parts should be replaced.

Ceiling and Wall Mount Inspection - (Figure 4.3) The ceiling or wall mount should be inspected for the following:

- All bolts and set screws must be fully tightened and secure.
- Ensure the horizontal arm is level. An unlevel horizontal arm may indicate the mounting pin is bent or fractured or the mount is not properly secured to the wall or ceiling.
- The horizontal and vertical arm assembly should remain in the position in which it was placed. Any drifting, drooping or swaying of the arm may indicate damage to the mounting pin. Examine the mounting pin and if loose or damaged, replace immediately.
- The horizontal arm should be inspected overall for cracks and any other loose or damaged parts. Any missing or damaged parts should be replaced.

Refer to the OCS Installation and Service Manual for additional information or contact Medrad Service.

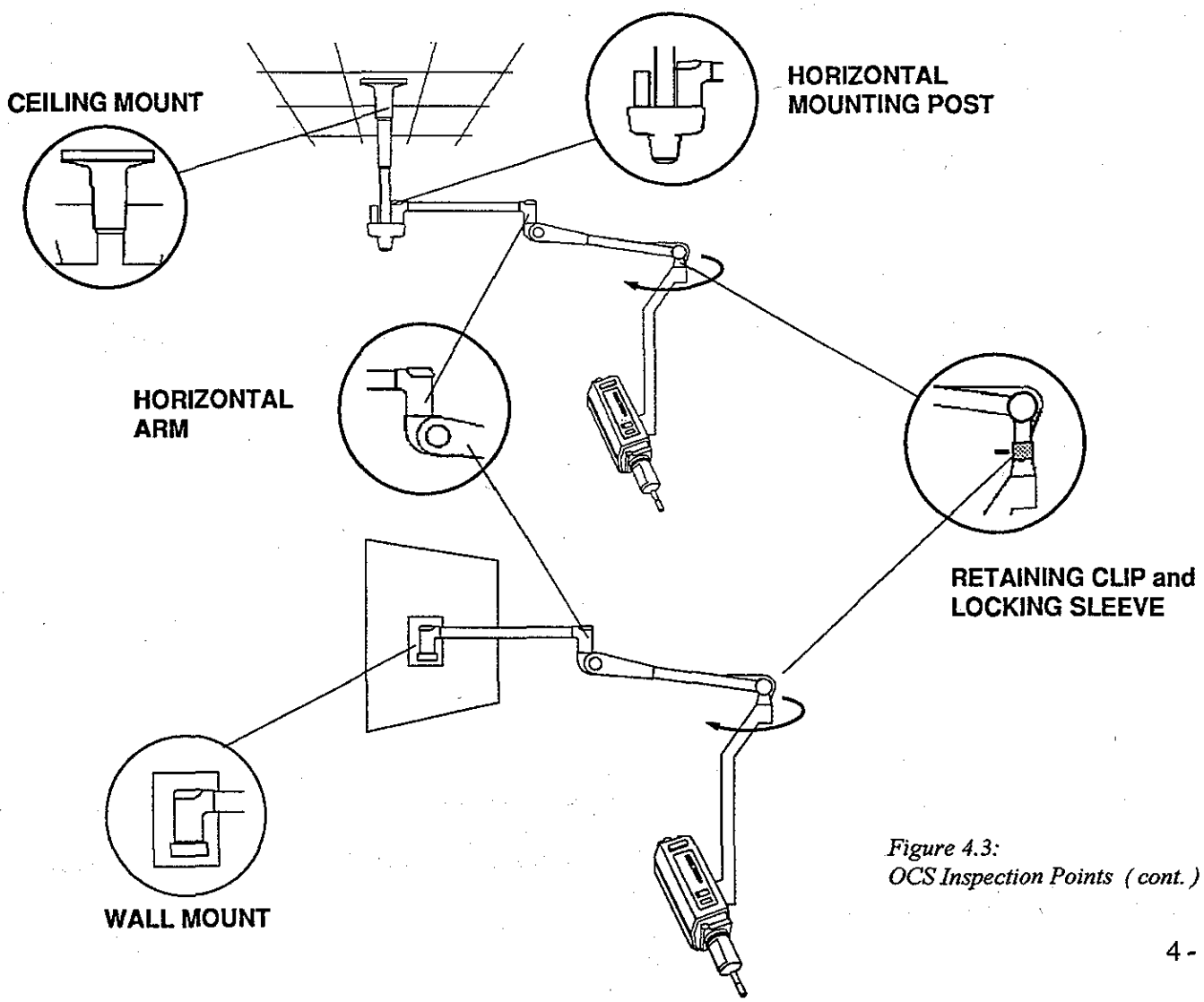


Figure 4.3:
OCS Inspection Points (cont.)

Cleaning Procedure

This procedure is recommended for the cleaning of a MCT/MCT *Plus* system. If not removed, contrast medium can interfere with proper operation.

WARNING: Remove the power cord from the power source before cleaning any part of the system. Failure to do this could result in the exposure of lethal voltages, causing injury or death.

- Using warm water and soft cloths, clean the injector console and head thoroughly to remove contrast medium or other deposits.
- *Non-Front Load head* Remove the turret, then clean the front casting where the piston moves in and out; Clean the turret and its pivot point; Remove any contrast from the entire length of the piston rod. Replace the turret.
- *Front Load head* Remove the Adaptor Plate and clean. With a warm cloth, clean the front plate and the entire length of the piston rod. Check the O-ring on the Front Plate for cuts, and to ensure that it is seated properly in the groove. Replace the Adaptor Plate.

CAUTION: Do not soak or immerse any parts of the injector in water. While cleaning the outside of the unit, avoid letting any water seep inside injector components.

- Allow time for the injector to dry thoroughly before using it. Do not dry by applying heat from any source.
- If contrast medium has leaked inside the injector head or console, the effected subassembly should be disassembled and cleaned. This cleaning procedure can be done in the field by trained Medrad Service personnel, or returned to Medrad Factory Service. If the cleaning will be performed in the field, do not disturb any internal wiring or components. **Ensure that the system is completely dry before applying power.**

Electrical Leakage Check

To insure safe operation of the injector, a chassis electrical leakage check must be part of preventive maintenance.

Use a commercial leakage tester such as one of the following:

Manufacturer	Model
Bio-Tek Instruments, Inc. Electrical Safety Analyzer	Model 501
Dynatech Nevada, Inc. Electrical Safety Analyzer	PEI Model 2000A
Ohmic Instruments Co.	BET-300 Series or HSM-200 Series

Procedure:

1. With the AC ground open, power applied, and the line at normal, leakage should be less than 100 micro amps (500 micro amps with -I units).
2. With the AC ground open, power applied and the line reversed, leakage should be less than 100 micro amps (500 micro amps with -I units).
3. Disconnect the leakage test box.

SECTION 5 - SYSTEM SPECIFICATIONS

Note: Medrad reserves the right to change product designs and specifications at any time in the continuing effort to improve their products. The following specifications refer to new units operating at room temperature (approximately 21 degrees C or 70 degrees F).

Control Console:

Dimensions:	Weight:	MCT		MCT *Plus*	
19" W (48 cm)	*Console*	42 lbs (19.0 kg)	*Console*	44 lbs.	(20.0 kg)
10 1/2" H (27 cm)	*Head*	18 lbs (8.0 kg)	*Head*	18 lbs.	(8.0 kg)
13" D (32 cm)	*Total System*	60 lbs (27.0 kg)	*Total System*	62 lbs.	(28.0 kg)

Remote Panel:

Dimensions:	Weight:
8" H (19 cm)	5 lbs (2.3 kg)
17" W (42 cm)	without cable
4" D (10 cm)	

Cord Lengths:

Power Cord	10 ft (3.0m) [MCT *Plus* -2 7ft (2.1m)]
Handswitch	25 ft (7.6m)
Injector Head	5 ft (1.5m)
Remote Panel	50 ft (15.2m) Std.
	100 ft (30.5m) Max.

Electrical Requirements:

Standby:	less than 1 Amp
Available:	95-105 VAC, 50 or 60 Hz, 4 A maximum
	105-120 VAC, 50 or 60 Hz, 4 A maximum
	120-125 VAC, 50 or 60 Hz, 4 A maximum
	190-210 VAC, 50 or 60 Hz, 2 A maximum
	210-240 VAC, 50 or 60 Hz, 2 A maximum
	240-250 VAC, 50 or 60 Hz, 2 A maximum

Electrical Leakage:

Chassis <100 microamps [MCT *Plus* -2 < 500 microamps]

Heat Dissipation:

Standby over 99% of the time):	300 BTU
Intermittently (<1% of the time):	1650 BTU
Average:	< 320 BTU

Load Rate:

MCT *Plus*	Forward/reverse: 8 to 30 seconds to move the entire length of the plunger.
MCT	Forward/reverse: 15 to 30 seconds to move the entire length of the plunger.

Syringe Heater:

37C (98F) nominal

Syringe:

Disposable: 200ml

System Specifications

Automatic Safety Stop:

Sets and locks itself automatically before each injection.
Sets and locks itself over the selected volume by 4.0 ml.

System Monitor:

Redundant circuitry terminates injection if any of these conditions occur:

Overrate	10ml/s for 100 ms
Overvolume	5ml or 50% whichever is less
Overpressure	100 psi

Flow Rate:

0.1 ml/s to 9.9 ml/s in 0.1 ml/s increments.

Total Volume Selection:

1 ml to 200 ml in 1 ml increments

Pressure Limit:

Factory Set at 300 psi. The pressure limiting for the MCT and MCT *Plus* is 300 psi, 21kg/cm², or 2069 kPa.

Status Readouts:

Volume Remaining	**Volume Delivered**	**Injection Duration**
Volume of Contrast available in the syringe prior to injecting. Read in 1 ml increments.	Amount of Contrast delivered during the last injection cycle Read in 1 ml increments.	Length of last injection in 1 sec. increments.

Scan Delay:

1 - 99 seconds

Program Memory:

A total of 6 memory positions of: 6 single or bi-phasic injections
or
5 single or bi-phasic, and 1 multi-level injection

Level Control - MCT w/software CU 1.4 and below:

Up to 2 phases (Volume and Flow Rate changes) per injection

Level Control - MCT/MCT *Plus* w/software CU2.0A and 2.1:

Up to 2 phases (Volume and Flow Rate changes) per injection with exception of memory program 6. Program 6 can have up to 10 phases (or 5 program levels).

Analog Output Signals (optional; included with ISI 100):

Injection Duration	Standby = < 0.1 VDC Injection = +5.0 VDC
Injection Volume	200 ml syringe: 0.6 VDC/10 ml
Injection Flow Rate	200 ml syringe: 2.0 VDC/10 ml /sec

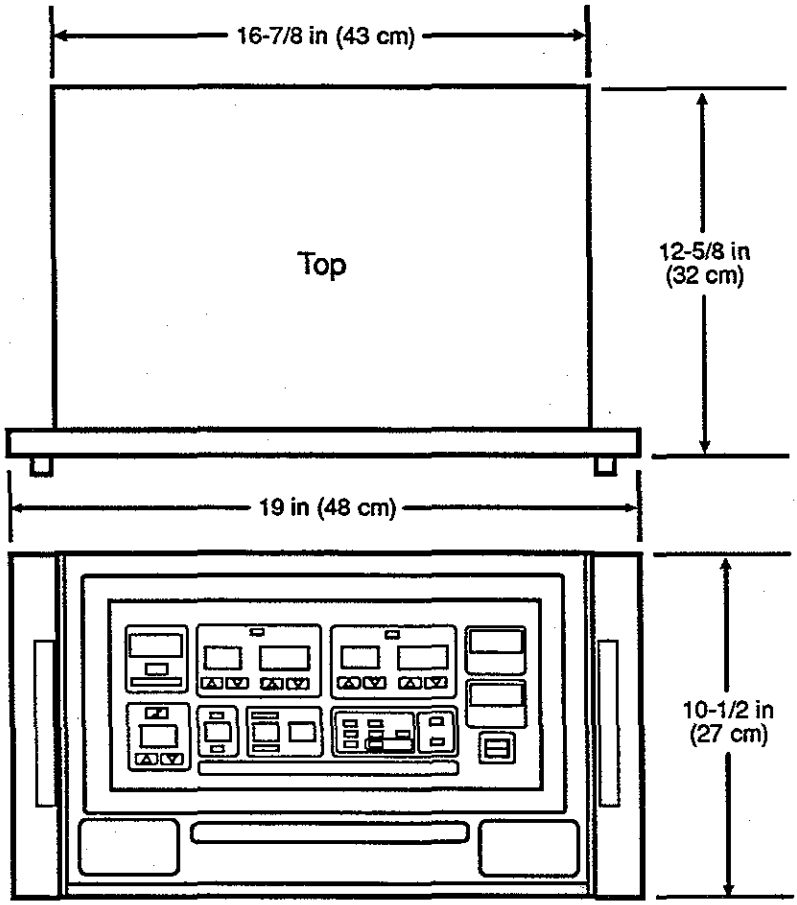


Figure 5.1:
CRC Dimensions

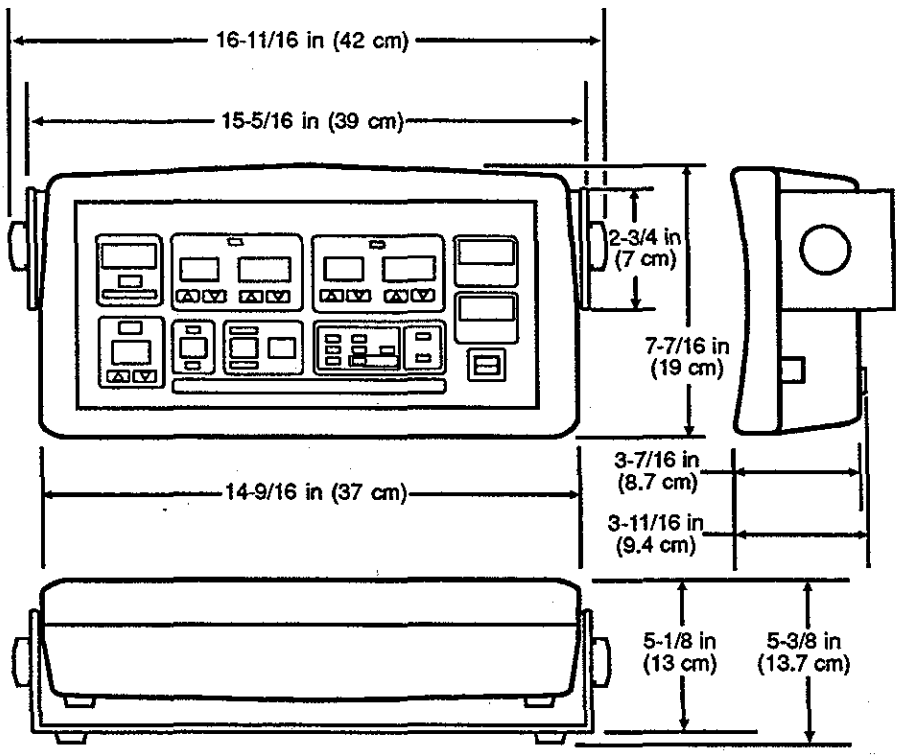


Figure 5.2:
Remote Panel Dimensions

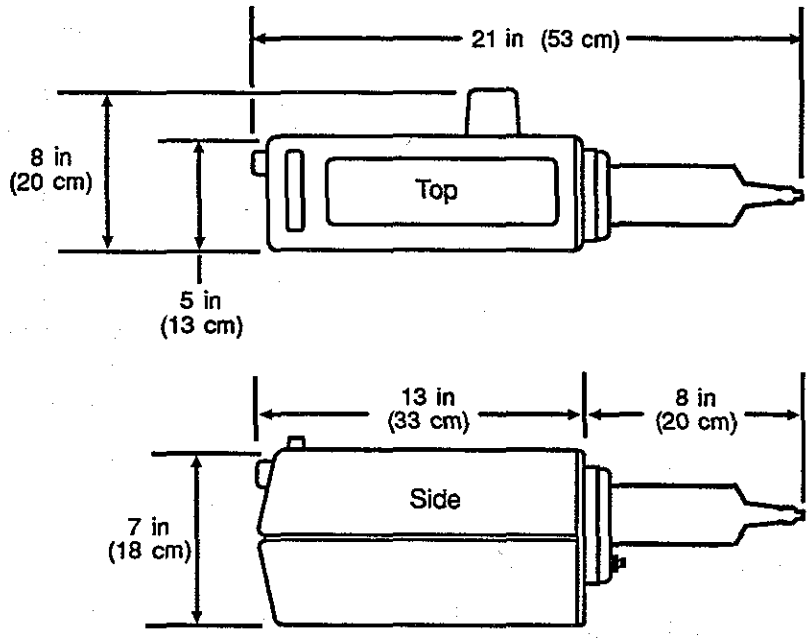


Figure 5.3:
Front Load Injector Head Dimensions

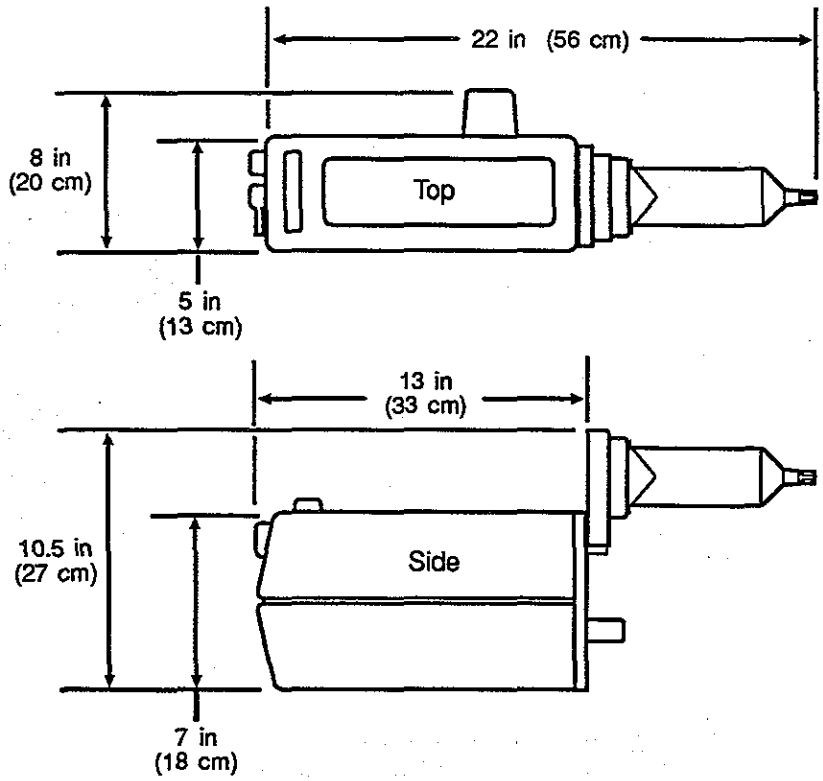


Figure 5.4:
Turret Style Injector Head Dimensions

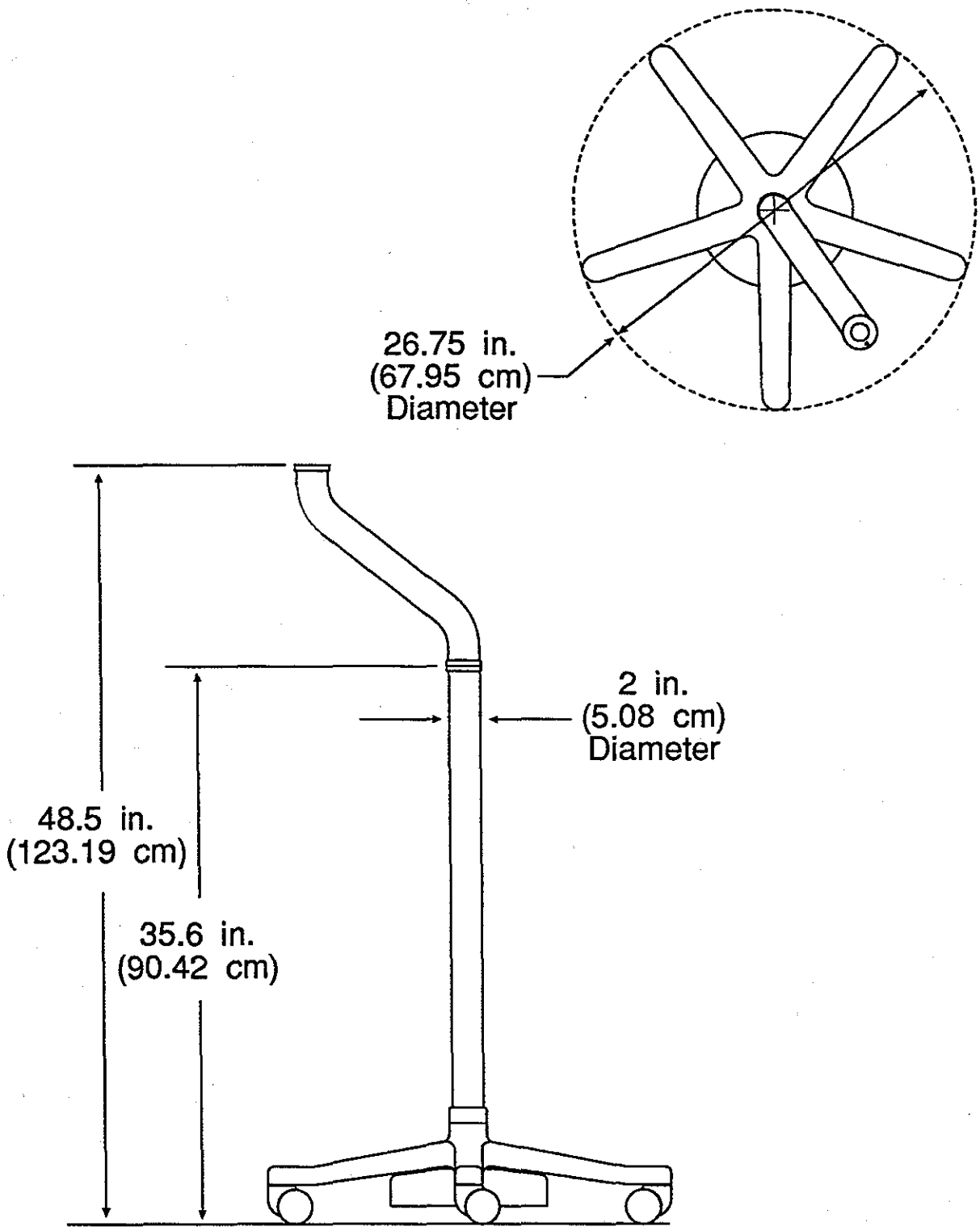


Figure 5.5:
KMA-320T Dimensions

Notes:

SECTION 6 - OPERATIONAL CHECKOUT

This section is an operational checkout procedure to be used in the verification of proper operation of the following units: Control Room Console MCT 305/310, and MCT 305P/310P, Remote Panel Systems RPS 350 and 350P. The following basic procedures are included:

- Entering information on the Control Panel.
- Saving a new program.
- Editing a program previously stored in memory.
- Recalling a program stored in memory.
- Changing a displayed value without affecting the stored program.

Entering an Injection Program

1.) Prior to programming the injector, apply power to the unit and reverse the head plunger completely by activating the **REVERSE** load on the head.

2.) Press the **PROGRAM SELECT** button until the desired **PROGRAM NUMBER** lights.

- Each time PROGRAM SELECT is pressed, the numbers advance in order from 1 to 6, then repeat. Program number 6 is the exclusive storage location for multi-level injections. Single and Bi-phasic injections can be stored under this Program Number, but the Program Number 6 memory address is the only one with the capacity to store multi-level injections. As many as 5 levels can be programmed per multi-level injection. Each level contains 2 phases, providing a total of ten phases available to the user.

- When programming the injector for the first time, we suggest starting with program number 1, then progressing in sequential order.

3.) If a multi-level injection is required, advance to storage location 6 using the PROGRAM SELECT key. Additional programming instructions for multi-level injections can be found on page 6 - 3.

4.) Press the **REPROGRAM** button. The **FIRST PHASE, SCAN DELAY,** and **SECOND PHASE** (if a two phase injection is selected) windows will flash.

5.) Select either a one or two phase injection by pressing the PHASE button, illuminating the proper indicator (**ONE** or **TWO**).

- **ONE PHASE** Injection: One selected flow rate and one selected volume.

- **TWO PHASE** Injection: Two selected flow rates and two selected volumes, one after the other, with no delay between phases.

6.) Enter the **FIRST PHASE** settings.

- Press either button under the **FLOW RATE ML/SEC** window until the desired flow rate between 0.1 and 9.9 ml/sec. is displayed in the window.

- Press either button under **VOLUME ML** until the desired volume between 1 ml and 200 ml is displayed in the window.

7.) Use the guidelines provided above in step 6 to program **SECOND PHASE** flow rate and volume..

8.) Enter a scan delay as follows:

- Press either button under **SCAN DELAY SECONDS** until the desired scan delay of up to 99 seconds is displayed in the window.

Normally five beeps will sound when the scan delay reaches zero during the countdown, alerting the operator to trigger the scanner. To eliminate the sound of the beep, press the SCANNER TONE ALERT [♪] key once.

To restore the beep, press the SCANNER TONE ALERT button. The unit will beep to indicate that the tone has been restored.

9.) To store the injection values currently displayed on the Control Panel, press the PROGRAM LOCK key. These values are now stored under the current PROGRAM NUMBER.

Multi-Level Programming

Software version CU 2.0 and EP 2.0 and later added the capability of multiple level injections to MCT injectors. The following procedures do not apply to software releases prior to CU 2.0.

Introduction

1.) Press the PROGRAM SELECT key until program number 6 is illuminated. This is the only program number with the capability to store Multi-Level programs.

2.) If a Multi-Level program has been previously stored, the INJECTION DURATION window will display PL 1.

3.) Press the REPROGRAM key. All programmable values on the Control Panel will flash. Multi-Level programming must start at PL 1.

Entering a Multi-Level Program

4.) Use the arrow keys to change Flow Rate, Volume, and Scan Delay. Each level must contain two phases in order to advance to the next higher level.

> **Note:** If Scan Delay is used, it must be programmed in the first level, and can not be set or changed in any program level above PL 1.

5.) Press the PROGRAM SELECT key to advance to the next level. Values in this level will also be flashing. Enter the desired values using the arrow keys. When both phases of this level are programmed, advance to the next level by pressing the PROGRAM SELECT key. A maximum of five two-phase levels can be programmed.

6.) When all values have been entered, press the PROGRAM LOCK key.

Previewing a Multi-Level Program

7.) To preview a Multi-Level program, advance to program number 6. The INJECTION DURATION (program level) window displays PL 1. Pressing the PROGRAM SELECT key will advance the program to Level 2 (PL 2). Once the PROGRAM SELECT key has advanced to the highest level in the Multi-Level program, pressing the PROGRAM SELECT key again reverts to program number 1.

Arming Sequence

8.) When arming the injector for Multi-Level injections, ensure that the highest PL level of the program is displayed in the INJECTION DURATION window. If this is not done, the message "SEE PL x" will be displayed in the Phase windows. Press the PROGRAM SELECT key to advance to the highest injection level, then arm.

Editing a Multi-Level Program

9.) Multi-Level programs are edited in the same way as single level programs. Page 6 - 5 of this section explains how to edit stored injection programs.

Erasing a Multi-Level Program

10.) To erase one level of a Multi-Level program, advance to the level to be deleted, then press the REPROGRAM key. While the displayed values are flashing, press the SYSTEM ABORT/ RESET key.

CAUTION: *The current level will be eliminated ALONG WITH ALL LEVELS ABOVE THE DELETED LEVEL. A single level can be deleted ONLY WHEN THE LEVEL TO BE DELETED IS THE HIGHEST LEVEL OF THE MULTI-LEVEL INJECTION.*

Press the PROGRAM LOCK key to complete this sequence.

To UN-DO an Erase

11.) If it is decided to retain the original Multi-Level program before the PROGRAM LOCK button is pressed , press the SYSTEM ABORT/RESET bar to scroll downward until PL 1 is displayed in the Injection Duration window. Pressing the SYSTEM ABORT/RESET bar at this level will reset the Control Panel so that it stops flashing and the original Multi-Level program has been reinstated. The original Multi-Level program can be reviewed by pressing the PROGRAM SELECT key.

Total Volume Indication

The VOLUME DELIVERED window will display Total Volume Selected if the PROGRAM LOCK key is pressed when the unit is not in the reprogramming mode.

While reprogramming a Multi-Level injection, the VOLUME DELIVERED window will display the total volume programmed in all levels.

Storing an Injection Program

1.) After entering desired values in the reprogram mode, press the **PROGRAM LOCK** button, saving the program as displayed.

- The program displayed on the Control Panel is now stored in the PPI memory.

- Any values that were flashing will now stop.

- The injection program is now stored in the program location illuminated in the **PROGRAM NUMBER** display.

-To confirm that the injection has been stored, press the Program Select button until the desired program number is selected.

2.) To enter and save another program , press the **PROGRAM SELECT** button to advance to the next unused **PROGRAM NUMBER** (or any other storage location), then repeat the steps as described under *Entering and Saving programs*

Recalling a Stored Injection Program

To recall a stored injection program, press the PROGRAM SELECT button until the program location of the desired program is illuminated on the Control Panel. The Control Panel will then display the values stored for the selected injection sequence.

Editing a Stored Injection Program

Once an injection sequence is stored in the MCT/MCT *Plus*, the injection parameters can be edited to either temporarily or permanently modify the stored program.

To permanently modify the stored program:

1.) Press the **PROGRAM SELECT** button until the desired **PROGRAM NUMBER** is illuminated. The Control Panel windows will display the injection values that have been stored.

Select the phase that is desired, ONE or TWO.

2.) Press the **REPROGRAM** button: All injection parameters will flash. Enter the new injection parameters and delay settings to be stored. The VOLUME DELIVERED window will display the TOTAL VOLUME SELECTED for the entire injection, be it single or multi-level.

Any value can now be selected for the **FIRST PHASE, SECOND PHASE** or **SCAN DELAY.**

3.) To store the injection program as displayed, press the PROGRAM LOCK button.

Any windows that were flashing will stop, and the program is now permanently stored in the PPI memory.

Editing the Display Without Affecting the Stored Program

When a program is recalled, any value on the Control Panel can be changed to alter the injection for a particular procedure, without affecting the permanently stored program.

1.) Press the **PROGRAM SELECT** button until the desired **PROGRAM NUMBER** is illuminated.

- The Control Panel will display the injection values that are stored.

DO NOT PRESS THE REPROGRAM BUTTON

2.) Enter the desired value changes.

- Enter any desired value changes for **FIRST PHASE, SECOND PHASE,** or SCAN DELAY. When a value change occurs, the **PROGRAM NUMBER** indicator light will flash from left to right. This indicates that the currently modified program no longer displays the stored injection values.

- In order to create a two-phase injection from an existing one-phase injection, press the PHASE button. The **TWO** phase indicator will illuminate, and the second phase windows will display default values. The desired second phase values can then be programmed.

- Likewise, in order to create a one-phase injection from an existing two-phase injection, press the **PHASE** button. The ONE phase indicator will illuminate and second phase values will no longer be displayed on the Control Panel.

3.) When the Control Panel is programmed as desired, the user can proceed with the other details of the injection. The stored program is not affected by the changes made.

4.) To restore the original recalled program, press the **PROGRAM** SELECT button once. The program number light will then stop flashing and remain illuminated.

Hold Feature (Single Arm Only)

During a contrast enhanced CT procedure, patient discomfort occasionally dictates that the injection/scan be stopped. The operator can then resolve the patient's discomfort and resume the procedure. The "Hold" feature allows the operator to stop the injection for up to 5 minutes. Leaving the MCT/MCT *Plus* in "Hold" for greater than five minutes will disarm the injector, and trigger the "SEE OP 115" Message to appear on the Control Panel.

Note: When the injector is set for MULTIPLE arm, the Hold feature is disabled. If the START key is depressed during a MULTIPLE arm injection, the current injection will be aborted and the injector will re-arm if sufficient volume remains in the syringe.

If the start switch is depressed after a single arm injection has begun, the Hold feature is initialized and the following sequence will occur:

1.) The injection stops or " freezes."
2.) The VOLUME DELIVERED and INJECTION DURATION values "freeze."
3.) The SCAN DELAY countdown stops.
4.) The Phase light above the currently active FLOW-VOLUME window will blink.
5.) The first phase FLOW-VOLUME window will display and flash the word "Hold."
6.) All second phase information (if used) will blank out.

If the START switch is then pressed again, the MCT/MCT *Plus* will beep five times if the scan delay has previously reached zero, alerting the operator to trigger the scanner. If the scan delay has not reached zero, the procedure will resume from where the injection left off. Each time the START switch is depressed, the sequence in steps 1 through 6 will be repeated until the entire programmed CT injection is completed.

When in the "Hold" mode, if it is decided to terminate the procedure, pressing **RESET** or any other key will disarm the injector, triggering the "**SEE OP 101**" Message code to appear. Pressing **RESET** again will return the MCT/ MCT *Plus* to the standby mode.

SECTION 7 - CPU CARD SUMMARY OF OPERATION

CPU Card Summary of Operation

There are two versions of the CPU Card, identified by the card revision level, part number, and serial number. Use the table below to determine which card type the injector has, then refer to the appropriate description on the following pages.

Assembly No.	Revision	Serial Number	CPU Card Type
78101-10-PC-01	Rev. E and above	20000 to 27467	Type B
78101-10-PC-14	Rev. A and above	Above 27467	Type C

CPU Card

CPU Card Type B (Part Number 78101-10-AP-01, serial numbers 20000 - 27467)

The CPU Card contains the main injector operating program. Refer to the figure on page 7 - 3 for a block diagram of the CPU Card type B. The CPU Card contains the following circuits:

CPU

The Z-80 CPU U10 is supported by 32 Kbytes of EPROM, and 8 Kbytes of RAM. This processor provides a 16-bit address bus, an 8-bit data bus, and several control lines for Read/Write, Interrupts, etc.

Clock

Crystal Y2 (8 MHz) and clock generator chip U2, produce the 4 MHz clock system for the CPU, and provide a Reset pulse when power is first applied. This pulse resets the CPU, and ensures that the program starts at the beginning.

Memory

The CPU memory is comprised of four EPROM chips (U11 through U14), and one RAM chip (U16). These chips connect the address and data buses, and are controlled by the enable lines from the memory / I/O decoder, and the Read/Write lines from the CPU. If these chips need to be replaced, contact Medrad Service for current revision EPROMS.

Memory / Input/Output Decoder

The Memory / Input/Output Decoder, comprised of U22 and U23, provides:

- Control of the memory chips during read/write cycles
- Two major decode lines (MEMIO1 and MEMIO2: Pins 16 and 17) that are buffered and sent to the Input/ Output Card
- Direction control for the data buffer

Bus Buffers

The control lines from the CPU are buffered by U17, then sent to the motherboard bus. The address bus is buffered by U18 and U19, then sent to the motherboard bus. The flow of data is controlled by bidirectional buffer U20, which is controlled by the Memory / I/O Decoder. Control and addressing lines flow away from the CPU, while the buffered data bus, can flow in either direction.

Watchdog 1

The CPU watchdog (U3) must receive pulses from the I/O Card on the WATCHDOG 1 line, or CPU operations will be interrupted. The pulses are generated on the I/O Card, by decoding a CPU address. A loss of these pulses is most likely the result of a problem with the CPU or the EPROMs.

Test Section

The circuit surrounding U7 is used for in-house testing, and the enabling of Utility programs.

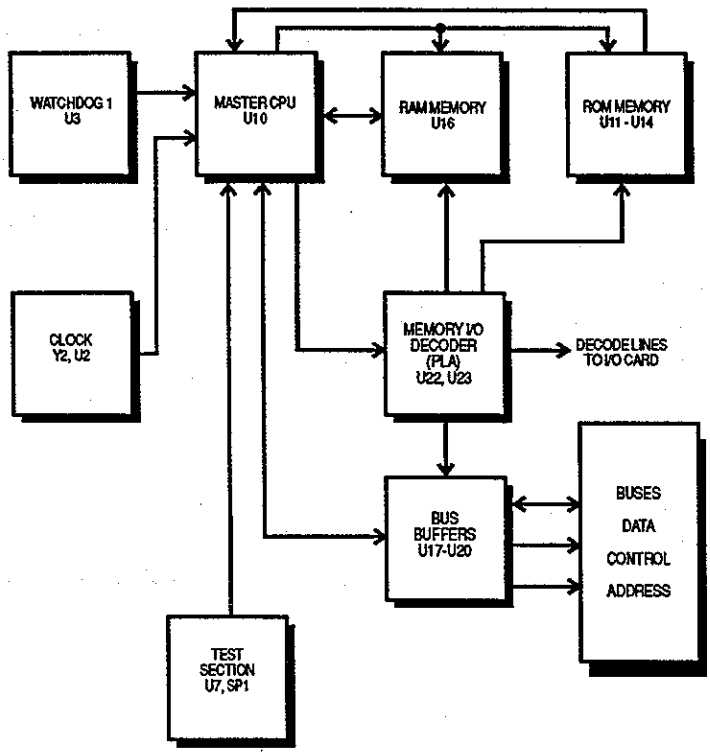


Figure 7.1: Block Diagram: CPU Card Type B

CPU Card

CPU Card Type C (Part Number 78101-10-AP-14, serial numbers above 27467)

The CPU Card contains the main injector operating program. Refer to the figure on page 7 - 5 for a block diagram of the CPU Card type C. The CPU Card contains the following circuits:

CPU

The Z-80 CPU U10 is supported by 64 Kbytes of EPROM, and 8 Kbytes of RAM. This processor provides a 16-bit address bus, an 8-bit data bus, and several control lines for Read/Write, Interrupts, etc.

Clock

Crystal Y2 (8 MHz) and clock generator chip U2, produce the 4 MHz clock system for the CPU, and provide a Reset pulse when power is first applied. This pulse resets the CPU, and ensures that the program starts at the beginning.

Memory

The CPU memory is comprised of one EPROM chip (U24), and one RAM chip (U16). These chips connect the address and data buses, and are controlled by the enable lines from the memory / I/O decoder, and the Read/Write lines from the CPU. EPROM chip U24 is only accessed when switch SP2-2 is set to the "U24" position. If this chip must be replaced, contact Medrad Service for a current version EPROM. In addition to standard memory, a seperate EPROM chip (U25) may be installed to access special utility functions. This may be accessed by setting switch SP2-2 to the "U25" position. Contact Medrad Factory Service for more information.

Memory / Input/Output Decoder

The Memory / Input/Output Decoder, comprised of U23 and U26, provides:

- Control of the memory chips during read/write cycles
- Two major decode lines (MEMIO1 and MEMIO2: Pins 16 and 17) that are buffered and sent to the Input/ Output Card
- Direction control for the data buffer

Bus Buffers

The control lines from the CPU are buffered by U17, then sent to the motherboard bus. The address bus is buffered by U18 and U19, then sent to the motherboard bus. The flow of data is controlled by bidirectional buffer U20, which is controlled by the Memory / I/O Decoder. Control and addressing lines flow away from the CPU, while the buffered data bus, can flow in either direction.

Watchdog 1

The CPU watchdog (U3) must receive pulses from the I/O Card on the WATCHDOG 1 line, or CPU operations will be interrupted. The pulses are generated on the I/O Card, by decoding a CPU address. A loss of these pulses is most likely the result of a problem with the CPU or the EPROMs.

Test Section

The circuit surrounding U7 is used for in-house testing, and the enabling of Utility programs.

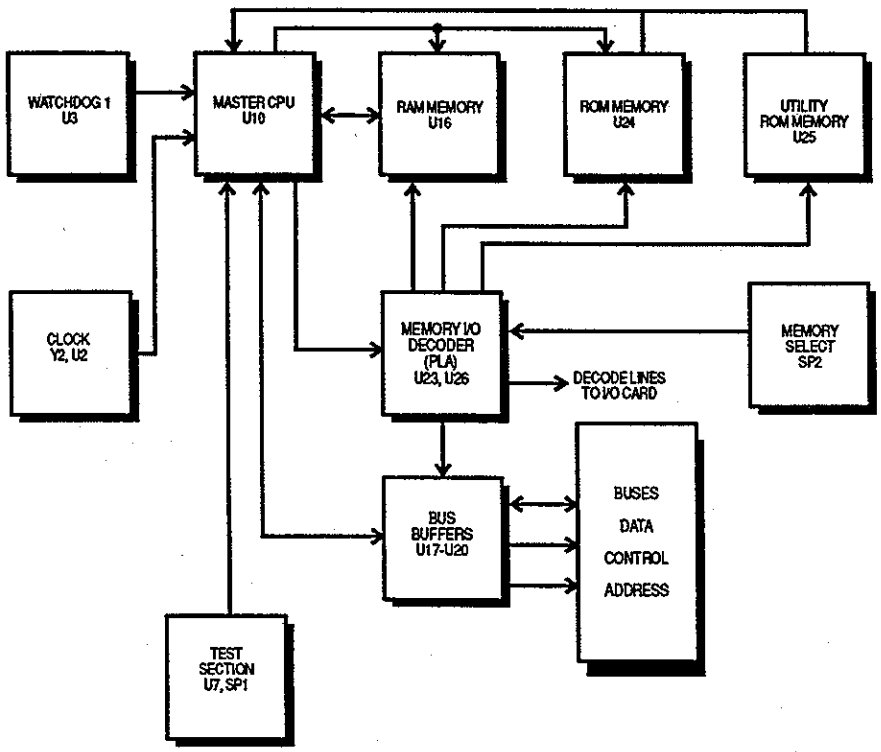
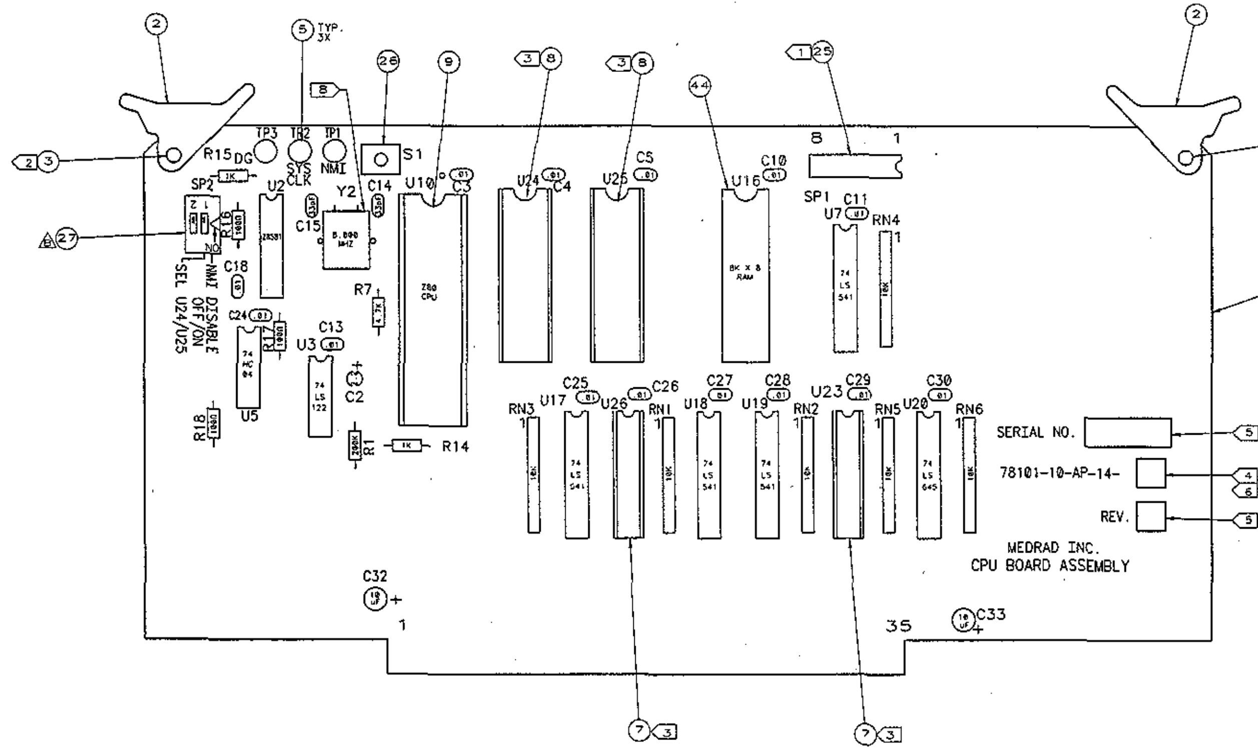


Figure 7.2: Block Diagram: CPU Card Type C

CPU Card

Serial Number	*Card Part Number*	*Chip Designation*	*Chip Part Number*
CPU 2XXXX to 27467	78101-10-AP-01 (-4)	U11	CU 2.1 U11
		U12	CU 2.1 U12
		U13	CU 2.1 U13
		U14	CU 2.1 U14
		U22	M5JA22
		U23	M5JA23
CPU 27468 and Above	78101-10-AP-14 (-4)	U24	CU 2.1 U24
		U23	M5JA23
		U26	M5JA26

REV	ECO NO.	DESCRIPTION	DATE	APPRO.
A	I0024	INITIAL RELEASE	2/10/92	RTB
B	EC748	REV SP2 DETAIL FOR CLARITY, ITEM 22 QTY. REV.	6-2-92 SCS	6-3-92 RTB
C	EC809	ADDED NOTE 7, JUMPER DETAIL	7/21/92	7/21/92
D	EC-917	ADDED R17,18, (LOC C-8), REV. NOTE 7	10/26/92	10/26/92
E	EC-990	ADDED NOTE 8	1/4/93	1-6-93
F	EC-1048	PROCESS CODE CHANGES	2-26-93 SCS	DPK



PROCESS COMPATABILITY CHART			
ITEM/ DESIG.	DO NOT WAVE SOLDER	DO NOT VAPOR DEGREASE	DO NOT WATER WASH
2,3	X		

NOTES:

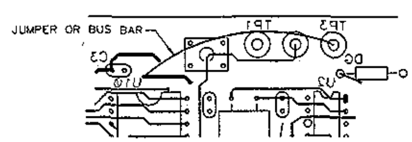
1. LEAVE PLASTIC CAPS ON SP1 & SP2 DURING WAVE SOLDER AND CLEANING REMOVE DURING TOUCH UP.
2. MASK COMPONENT LOCATIONS FOR PARTS MARKED "DO NOT WAVE SOLDER" PRIOR TO WAVE SOLDER. INSTALL PARTS MARKED "DO NOT WAVE SOLDER" AFTER WAVE SOLDER. HAND CLEAN ANY PARTS MARKED "DO NOT VAPOR DEGREASE" OR "DO NOT WATER WASH".
3. U24-U25, U26, AND U23 ARE INSTALLED AT A HIGHER LEVEL. COMPONENT DESIGNATORS ARE SHOWN FOR REFERENCE ONLY.
4. FINAL ASSEMBLY OF THIS CARD FOR STD. MARK V, MARK V PLUS AND MCT INJECTOR SYSTEMS IS AS NOTED BELOW:

INJECTOR SYSTEM	USE FINAL ASSY DWG.NO.
MKV/MK V PLUS	78101-10-AP-14-3
MCT/MCT PLUS	78101-10-AP-14-4

5. SERIAL NO. AND REVISION TO BE APPLIED USING PERMANENT INK, OR PRE-PRINTED LABEL (ITEM 6)
6. T/A TO FILL IN BOARD P/N BLOCK DURING BOARD CALIBRATION TEST.

7. FOR REV B PC BOARDS ONLY. ADD A 22 AWG JUMPER WIRE (P/N 703-0122-009) OR 22 AWG BUS BAR AND TUBING. (P/N 706-0122-000 & 712-2000-022) ON THE SOLDER SIDE OF THE PCB FROM THE DG TEST POINT (TP3) TO THE FEED THROUGH HOLE ABOVE U10 TO THE LEFT OF C3.

8. USE ADHESIVE TO FASTEN Y2 TO THE BOARD. USE RTV OR EQUIVALENT REMOVABLE SILICON BASED ADHESIVE.



SOLDER SIDE

7-7

SIGNATURES	DATE
DRAWN E.J. PAVLOCK	1/20/92
CHECKED B.J. O'HELLA	1/20/92
R.T. BULLINGER	2/10/92
G.E. HINTERMEYER	2/10/92

DO NOT SCALE DRAWING

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MEDRAD INC.
271 KAPPA DRIVE
PITTSBURGH, PA 15238

TITLE: MK V/MCT INJECTOR C.P.U. BOARD ASSEMBLY

SIZE D | DWG. NUMBER 78101-10-AP-14-1 | REV F

SCALE 2X | SHEET 1 OF 2

BILL OF MATERIAL

ITEM	DESCRIPTION	PART NUMBER	QTY.	REF. DESIG.	PROCESS CODE	PREP. CODE
1	PC CARD REV C AND UP	78101-10-PC-14	1		LG	D
2	CARD EJECTOR, WHITE	510-7000-000	2		AW	
3	CARD EJECTOR PIN	510-7001-000	2		AW	
4						
5	TUBULAR TERMINAL	642-1238-000	3	DG,SYS CLK,NMI	BW	
6	LABEL, BLANK SERIAL NO	550-0093-652	1		BW	NOTE 5
7	IC SOCKET, 20 PIN	545-8201-020	2	U26,U23	LG	
8	IC SOCKET, 28 PIN	545-8281-028	2	U24,U25	LG	
9	IC SOCKET 40 PIN	545-8401-040	1	U10	LG	
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20	CAP, 10 UF, 35V	204-0106-135	2	C32,33	LG	.1-LS
21	CAP, 2.2 UF, 35V	206-0225-350	1	C2	LG	.1-LS
B 22	CAP, .01 UF, 50V	201-0103-050	14	C3-5,10,11,13,18,24-30	LG	.1-LS
23						
24	CAP, 33PF, 100V	201-0330-100	2	C14,15	LG	.1-LS
25	SWITCH,DIP,16 PIN SPST	450-4358-021	1	SP1	BW	
26	SWITCH,KEY,SPST MOMENTARY	450-1152-000	1	S1	LG	
27	SWITCH, DIP, 2 POS	450-7802-002	1	SP2	BW	
28	CRYSTAL, 8.0 MHZ	180-0080-020	1	Y2	LG	
29						
30	RESISTOR, 200K OHM 1/4W 5%	303-0204-000	1	R1	AXI	5BEND
31	RESISTOR, 100 OHM 1/4W 5%	303-0101-000	3	R16,17,18 D	AXI	5BEND
32	RESISTOR, 4.7K OHM 1/4W 5%	303-0472-000	1	R7	AXI	5BEND
33	RESISTOR, 1K OHM 1/4W 5%	303-0102-000	2	R14,R15	AXI	5BEND
34						
35	RESISTOR ARRAY, 10K OHM SIP	340-4310-103	6	RN1-6	LG	5BEND
36						

ITEM	DESCRIPTION	PART NUMBER	QTY.	REF. DESIG.	PROCESS CODE	PREP. CODE
37						
38						
39						
40	IC,CLOCK CONTROLLER,Z8581	070-8581-000	1	U2	DIP	
41	IC,MONOSTABLE,74LS122	074-74LS-122	1	U3	DIP	
42	IC,HEX INVERTER,74PC04	080-74PC-004	1	U5	DIP	
43	IC,BUFFER,74LS541	074-74LS-541	4	U7,17-19	DIP	
44	IC,SRAM, 8K X 8	071-8464-000	1	U16	LG	
45	IC,BUS TRANS,74LS645	074-74LS-645	1	U20	DIP	
46	IC,Z80 CPU	070-8400-000	1	U10	AW	

SIGNATURES		DATE
DRAWN	E.J. PAVLOCK	1/30/92
CHECKED	B.J. O'HELLA	1/30/92
ENGR.	R.T. BOLLINGER	2/10/92
PROJ. MGR.	G.F. HINTERMEYER	2/10/92

SEE SHT. 1 FOR REV. LEVEL

MEDRAD INC.
271 KAPPA DRIVE
PITTSBURGH, PA 15238

TITLE
MKV/MCT INJECTOR
CPU BOARD ASSEMBLY

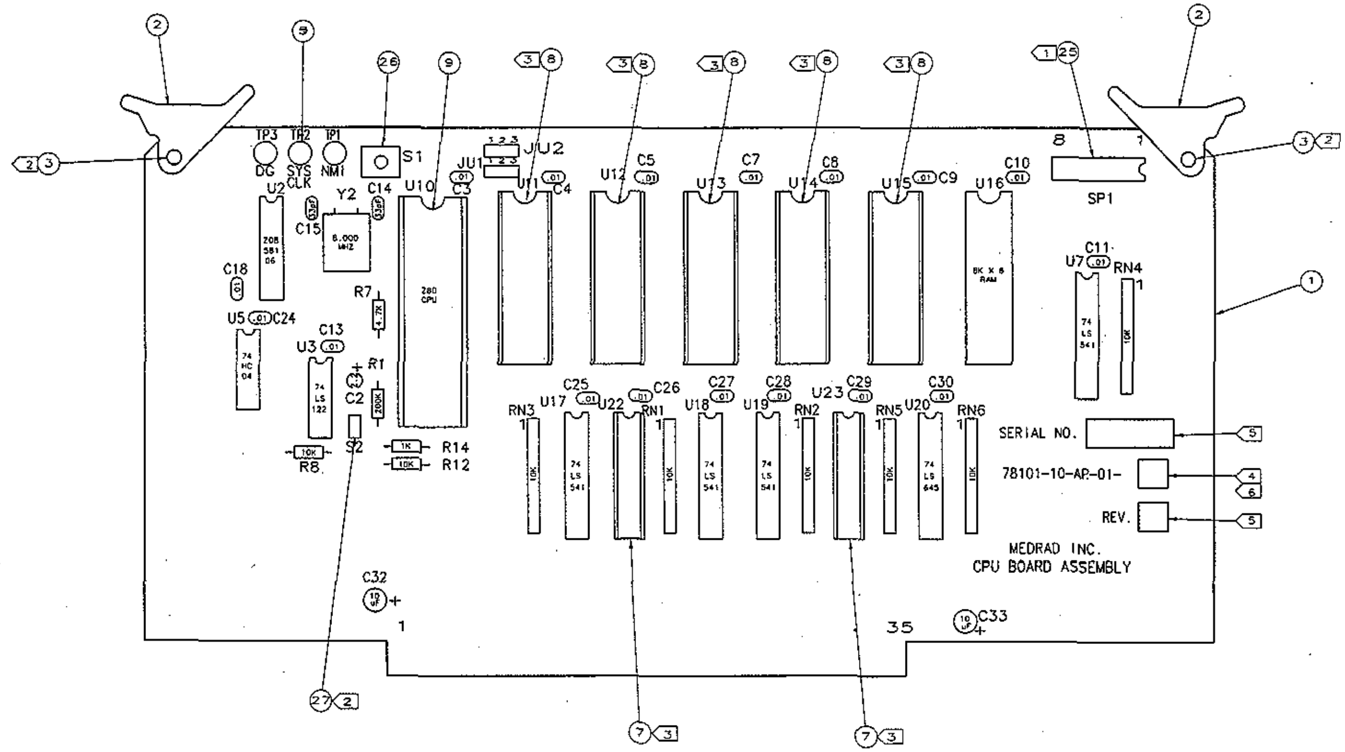
DWG. NUMBER 78101-10-AP-14-1 REV. F

DATE COPIED

SHEET 2 OF 2

Plot:Mon 3-1-1993

REV	ECO NO.	DESCRIPTION	DATE	APPVD.
A	DDN-126	...D PARTS LIST, CORRECTED C1,C6,C11 IN... RELOCATED C30 ADDED 915, REV. NOTE 1	3/21/86 TI	3/24/86 MGF
B	DDN-127	R14 WAS 10K	3/28/86 WAK	3/28/86 MGF
C	DDN-204	ITEM 5 QTY. WAS 6. DELETED NOTE H	2/13/87 JCB	2/17/87 AJY
D	DDN-282	ADDED CPU ID FOR U10	11/30/87 JCB	12/1/87 AJY
E	DDN-321	ADDED ITEMS 8,9, REV. NOTES F, I	5/11/88 JCB	5/12/88 AJY
F	DDN-346	REVISED NOTE F-2	7/6/88 JCB	6/7/88 JS
G	DDN-384	REVISED NOTE B	11/18/88 WAK	11/21/88 AJY
H	DDN-459	78101-00-PX-02 IN NOTE F1 WAS 78101-10-PX-02 CR 78101-10-90	5/2/89 JCB	5/2/89 AJY
I	DDN-500	REV NOTE A. CR 10000-NS-306	9/8/89 JCB	9/12/89 AJY
J	DDN-532	REV PROG. NO'S AT NOTES F, I ADDED NOTE H. CR10000-NS-358	11/3/89 JCB	11/6/89 AJY
K	DDN-565	CUT CONDUCTOR BETWEEN U3 PIN5 AND U3 PIN6. CR 78101-10-107	1/17/90 BJD	1/17/90 AJY
L	DDN-668	REF. CR 10000-NS-495	6/22/90 JCB	7/5/90 THR
M	DDN-723	REV. PROC. COMPAT. CHART FOR S2 CR 78101-10-122	9/19/90 JCB	9/19/90 AJY
N	EC-11	REV. FOR MK V PLUS. REV. NOTES F, K	11/28/90 JCB	11/29/90 AJY
P	EC-239	REV. NOTE G FOR ALT. CIRCUIT HOLE SOLDER MASK	6/24/91 JCB	6/27/91 DPK
R	EC-393	REDRAWN ON CAD. ADD SHT. 2	8/2/91 MAW	9/12/91 DPK
S	EC-404	CORRECTED WRONG PART NUMBER	9/27/91 MAW	9-30-91 [illegible]



NOTES:

1. LEAVE PLASTIC CAP ON SP-1 DURING WAVE SOLDER AND CLEANING. REMOVE DURING TOUCH UP.
2. MASK COMPONENT LOCATIONS FOR PARTS MARKED "DO NOT WAVE SOLDER" PRIOR TO WAVE SOLDER. INSTALL PARTS MARKED "DO NOT WAVE SOLDER" AFTER WAVE SOLDER. HAND CLEAN ANY PARTS MARKED "DO NOT VAPOR DEGREASE" OR "DO NOT WATER WASH"
3. U11-U15, U22, AND U23 ARE INSTALLED AT A HIGHER LEVEL. COMPONENT DESIGNATORS ARE SHOWN FOR REFERENCE ONLY.
4. FINAL ASSEMBLY OF THIS CARD FOR STD. MARK V, MARK V PLUS AND MCT INJECTOR SYSTEMS IS AS NOTED BELOW:

INJECTOR SYSTEM	USE FINAL ASSY DWG. NO.
STANDARD MK V	78101-10-AP-01-2
MK V PLUS	78101-10-AP-01-3
MCT/MCT PLUS	78101-10-AP-01-4

5. SERIAL NO. AND REVISION TO BE APPLIED USING PERMANENT INK, OR PRE-PRINTED LABEL (ITEM 6)
6. T/A TO FILL IN BOARD P/N BLOCK DURING BOARD CALIBRATION TEST.

PROCESS COMPATABILITY CHART

ITEM/ DESIG.	DO NOT WAVE SOLDER	DO NOT VAPOR DEGREASE	DO NOT WATER WASH
2, 3	X		
S2	X	X	X

7-9

SIGNATURES		DATE
DRAWN	BUTLER	7-8-85
CHECKED	VAZZERINSKI	10-31-85
ENGR.	VAZZERINSKI	10-31-85
	POTTER	10-31-85

DO NOT SCALE DRAWING

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MEDRAD INC.
271 KAPPA DRIVE
PITTSBURGH, PA 15238

TITLE: MK V/MCT INJECTOR (20K SERIES) C.P.U. BOARD ASSEMBLY

SIZE: D | DWG. NUMBER: 78101-10-AP-01-1 | REV: S
SCALE: 2X | SHEET 1 OF 2

BILL OF MATERIAL

ITEM	DESCRIPTION	PART NUMBER	QTY.	REF. DESIG.	PROCESS CODE	PREP. CODE
1	PC CARD, REV. H AND UP	78101-10-PC-01	1		LG	
2	CARD EJECTOR, WHITE	510-7000-000	2		AW	
3	CARD EJECTOR PIN	510-7001-000	2		AW	
4						
5	TUBULAR TERMINAL	642-1238-000	3	DG, SYS CLK, NMI	BW	
6	LABEL, BLANK SERIAL NO	550-0093-652	1		BW	NOTE 5
7	IC SOCKET, 20 PIN	545-8201-020	2	U22, U23	LG-016	
8	IC SOCKET, 28 PIN	545-8281-028	5	U11, U12, U13, U14, U15	LG-002	
9	IC SOCKET 40 PIN	545-8401-040	1	U10	LG-014	
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20	CAP, 10 UF, 35V	204-0106-135	2	C32, 33	LG-009	.1-LS
21	CAP, 2.2 UF, 35V	206-0225-350	1	C2	LG-015	.1-LS
22	CAP, .01 UF, 50V	201-0103-050	17	C3-5, 7-11, 13, 18, 24-30	LG-019	.1-LS
23						
24	CAP, 33PF, 100V	201-0330-100	2	C14, 15	LG-012	.1-LS
25	SWITCH, DIP, 16 PIN SPST	450-4358-021	1	SP1	LG-021	
26	SWITCH, KEY, SPST MOMENTARY	450-1152-000	.1	S1	LG-020	
27	SWITCH, SPST	450-4356-651	1	S2	BW	
28	CRYSTAL, 8.0 MHZ	180-0080-020	1	Y2	LG-011	
29						
30	RESISTOR, 200K OHM 1/4W 5%	303-0204-000	1	R1	LG-003	5BEND
31	RESISTOR, 10K OHM 1/4W 5%	303-0103-000	2	R8, 12	LG-001	5BEND
32	RESISTOR, 4.7K OHM 1/4W 5%	303-0472-000	1	R7	LG-007	5BEND
33	RESISTOR, 1K OHM 1/4W 5%	303-0102-000	1	R14	LG-005	5BEND
34						
35	RESISTOR ARRAY, 10K OHM SIP	340-4310-103	6	RN1-6	LG-017	5BEND
36						

ITEM	DESCRIPTION	PART NUMBER	QTY.	REF. DESIG.	PROCESS CODE	PREP. CODE
37						
38						
39						
40	IC, CLOCK CONTROLLER, Z8581	070-8581-000	1	U2	LG-008	
41	IC, MONOSTABLE, 74LS122	074-74LS-122	1	U3	LG-013	
42	IC, HEX INVERTER, 74PC04	080-74PC-004	1	U5	LG-010	
43	IC, BUFFER, 74LS541	074-74LS-541	4	U7, 17-19	LG-004	
44	IC, SRAM, 8K X 8	071-8464-000	1	U16	LG-018	
45	IC, BUS TRANS, 74LS645	074-74LS-645	1	U20	LG-006	
46	IC, Z80 CPU	070-8400-000	.1	U10	AW	

SIGNATURES	DATE
DRAWN M.A.WHALEN	8/12/91
CHECKED T.P. LANE	9/12/91
ENGR. A.J.YARZEBINSKI	9/12/91
PROJ. MGR. D.D.KLODOWSKI	9/12/91

SEE SHT. 1 FOR REV. LEVEL

MEDRAD INC.
271 KAPPA DRIVE
PITTSBURGH, PA 15238

TITLE
MKV/MCT INJECTOR (20K SERIES)
CPU BOARD ASSEMBLY

DWG. NUMBER 78101-10-AP-01-1 REV. S

DATE COPIED

SHEET 2 OF 2

SECTION 8 - INPUT/OUTPUT CARD SUMMARY OF OPERATION

I/O Card Summary of Operation

Through the I/O Card, the CPU:

- reads the status of the Control Panel, external switches, and system events
- operates the Control Panel displays and external connections
- synchronizes and times the injection

Refer to page 8 - 2 for a block diagram of the I/O Card. The following circuit groups comprise the I/O Card:

Bus Buffers

The control bus is buffered by U14, and the address bus is buffered by U15. The bidirectional data bus is buffered and controlled by U22, with direction control from I/O decoder U8.

Display Decoder

Signals for the Display Card on the Control Panel are provided by 4:16 decoder U1, while U7 inserts "Wait States" for the display drivers. These signals control the Sentinel and the display drivers for the LED displays.

Display Buffers

Two address lines, and eight data lines, are buffered for the Display Card by U16 and U19.

I/O Decoder

Decoder U8, controlled by address and control lines, provides an enable to the programmable I/O (PIO) chips U5 and U6, the counter/timer chip (CTC) U4, and, provides data direction control for the data buffer U22.

Parallel Input/Output Chips

Parallel I/O chips permit the CPU to access external inputs, and to control outputs.

PIO1 — The inputs to U6 are the hand start switch, remote start switch, and remote disarm input. Through the data buses, the CPU can check the digital status of these inputs.

Outputs from U6 include: The film changer relay enable, two injecting signals, Armed signal, and Head Indicator signals. Through the I/O chip, the CPU can turn these outputs on and off.

PIO2 — This device (U5) is dedicated to decoding of the keypad on the Control Panel. Port A (sense line) rotates a Logic-0 on each line on the keypad matrix. When a key is pressed, one line of Port B will go to Logic-0. The CPU compares Port A to Port B to determine which key was pressed.

Port A lines A0 - A3:	for the Main Keypad
Port A lines A4 - A7:	for the ECG/Scope Keypad *(not used in any MCT units)*

Counter/Timer Chip (CTC)

The CTC (U4) generates interrupt signals for the CPU. The interrupts are prioritized and asynchronous with the system clock.

- *Trigger 0: (Not used with MCT units, SYS 500-PI, or RMT 505-PI/510-PI)* R-wave detector interrupt request. When an R-wave is detected, an interrupt is generated. Trigger 0 has the highest priority and is used only with the ECG option.

- *Trigger 1:* PPI memory error interrupt request. PPI primary and backup memories are compared each time primary memory is read. If primary and backup data values are not equal, an interrupt request is generated.

- *Trigger 2:* UART (Universal Asynchronous Receiver-Transmitter) interrupt request. This indicates that the Remote Panel is requesting communication with the Main Unit.

- *Trigger 3:* Timed Interrupt. This provides a real-time clock and delay timer function. During an injection, this interrupt program performs Flow Rate and Volume Limit calculations. This interrupt is not externally triggered, but driven from the time divided clock generator.

Test Decoder

This 4:16 decoder (U2) provides Reset pulses for Watchdog 1, and controls timing of the buzzer.

Test Section

The circuit surrounding U17 and U18 is for in-house testing.

ECG Detector *(Not used in any MCT units)*

This circuitry is used only with the ECG option. The incoming R-wave signal is sent to the multiplying DAC circuit (U20, U21, U23, and U24 *or* U20, U21, and U26), while sensitivity to this signal is controlled by the Gain Up/Down keys on the ECG Keypad. Gain information is sent through the data bus to U20, which sets a multiplication factor for DAC U21. The output of the DAC is buffered (at U24 *or* U26A), then sent to the R-wave detector U23 *or* U26B, of which output is a pulse that indicates an R-wave. This pulse goes through a pulse shaping network (U25 *or* U27), then to CTC Trigger 0.

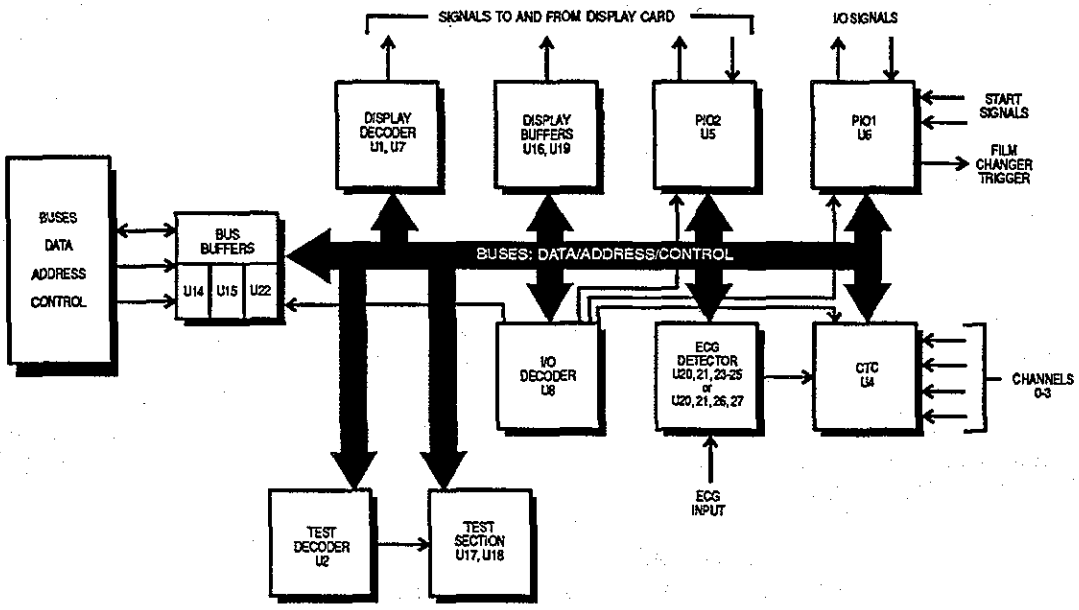
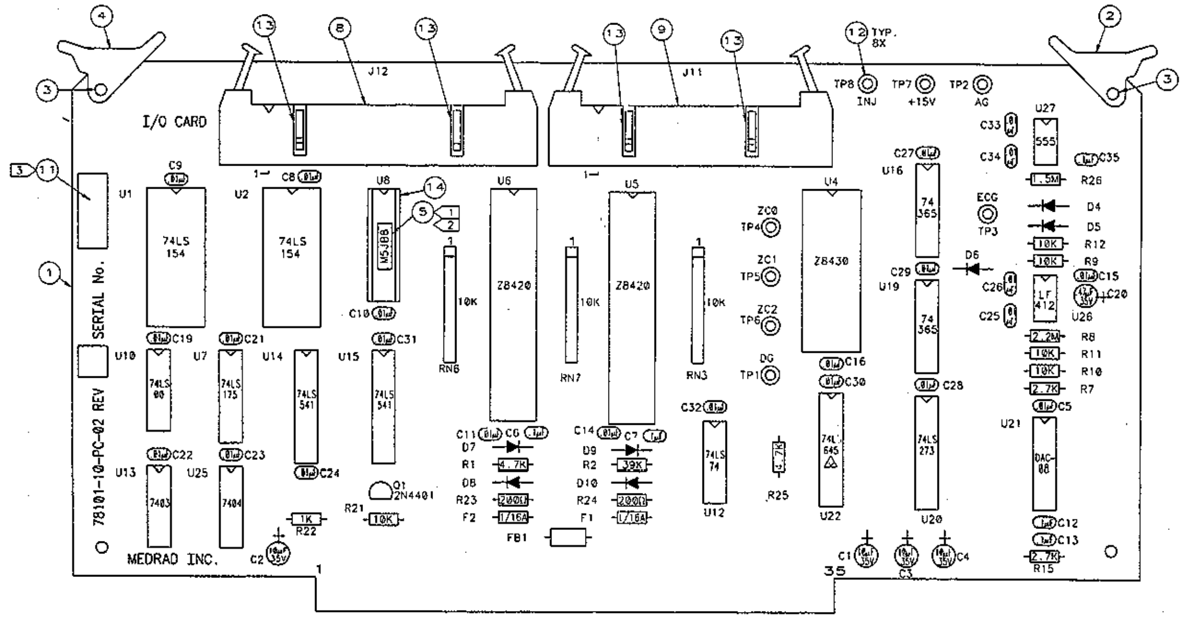


Figure 8.1: Block Diagram: I/O Card

REV	ECO NO.	DESCRIPTION	DATE	APPVD.
U	EC-554	ON CAD FOR REV. BOARD LAYOUT	1-16-92	RTB
V	EC-605	U22 (SHT.1) WAS 74LS273	2/17/92	DPK
W	EC-1048	PROCESS CODE CHANGES	2-25-93	DPK



4. MASK COMPONENT LOCATIONS FOR PARTS MARKED "DO NOT WAVE SOLDER" PRIOR TO WAVE SOLDER. INSTALL PARTS MARKED "DO NOT WAVE SOLDER" AFTER WAVE SOLDER. HAND CLEAN ANY PARTS MARKED "DO NOT VAPOR DEGREASE" OR "DO NOT WATER WASH".

PROCESS COMPATABILITY CHART

ITEM/DESIG.	DO NOT WAVE SOLDER	DO NOT VAPOR DEGREASE	DO NOT WATER WASH
2, 3, 4	X		

3. SERIAL NO. TO BE APPLIED USING PERMANENT INK, SCRIBE OR PRE-PRINTED LABEL (ITEM 11).

2. REFER TO DOCUMENT NO. 78101-10-SP-02 FOR MASTER DEVICE PROGRAMMING INSTRUCTIONS FOR U8. THIS DOCUMENT FOR ENGINEERING USE ONLY.

1. SEE INSTUCTIONS FOR PROGRAMMING U8 ON DOC. NO. 89064-00-PX-01 PRIOR TO INSTALLATION. (UNPROGRAMMED PT. NO. FOR U8 IS 071-8215-300 PROGRAMMED PT. NO. IS M5JB8) PAL LABELS ARE TO BE ATTACHED AFTER PROGRAMMING

NOTES:

SIGNATURES		DATE
DRAWN	JCB	3/5/84
CHECKED	MARK TROCKI	5-3-84
ENGR.	RHP	6/15/84

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MEDRAD INC.
271 KAPPA DRIVE
PITTSBURGH, PA 15238

TITLE: MKV INJECTOR I/O BOARD ASSEMBLY

SIZE D | DWG. NUMBER 78101-10-AP-02 | REV W

SCALE NTS | SHEET 1 OF 3

BILL OF MATERIAL

ITEM	DESCRIPTION	PART NUMBER	QTY.	REF. DESIG.	PROCESS CODE	PREP CODE
1	PC CARD, (REV O & UP)	78101-10-PC-02	1		LG	
2	CARD EJECTOR, WHITE	510-7000-000	1		AW	
3	CARD EJECTOR PIN	510-7001-000	2		AW	
4	CARD EJECTOR, VIOLET	510-7003-000	1		AW	
5	LABEL, BLANK EPROM	550-0017-619	1	U8	AW	NOTE 1
6						
7						
8	CONNECTOR, 40 PIN HEADER	518-0208-040	1	J12	BW	
9	CONNECTOR, 34 PIN HEADER	518-0208-034	1	J11	BW	
10						
11	LABEL, BLANK SERIAL NUMBER	550-0093-652	1		BW	NOTE 3
12	TUBULAR TERMINAL	642-1238-000	8	AC,DC,BECC,ZC0,ZC1,ZC2,+15,DN	BW	
13	POLARIZING KEY	518-3518-000	4	J11,J12	BW	
14	IC SOCKET, 20 PIN	545-8201-020	1	U8	LG	
15						
16						
17						
18						
19						
20	FERRITE BEAD	280-1625-000	1	FB1	LG	5 BEND
21	CAPACITOR, 10μF, 35V	204-0106-135	4	C1,C2,C3,C4	LG	.1-LS
22	CAPACITOR, .47μF, 35V	206-0474-350	1	C20	LG	.1-LS
23	CAPACITOR, .01μF, 50V	201-0103-050	23	C5,C8-C11,C14-C16,C19,C21-C34	LG	.1-LS
24	CAPACITOR, .1μF, 50V	201-0104-050	5	C6,C7,C12,C13,C35	LG	.1-LS
25						
26						
27						
28						
29						
30	FUSE, 1/16A, PICO	476-0062-000	2	F1,F2	LG	5 BEND
31						
32						
33						
34						
35	TRANSISTOR, 2N4401	120-4401-000	1	Q1	BW	
36						

ITEM	DESCRIPTION	PART NUMBER	QTY.	REF. DESIG.	PROCESS CODE	PREP CODE
37	DIODE, 1N4148	105-4148-000	7	D4-D10	AXI	5 BEND
38						
39						
40	RESISTOR, 2.7 KOHM, 1/4W, 5%	303-0272-000	2	R7,R15	AXI	5 BEND
41	RESISTOR, 10 KOHM, 1/4W, 5%	303-0103-000	5	R9-R12,R21	AXI	5 BEND
42	RESISTOR, 2.2 MOHM, 1/4W, 5%	303-0225-000	1	R8	AXI	5 BEND
43	RESISTOR, 200 OHM, 1/4W, 5%	303-0201-000	2	R23,R24	AXI	5 BEND
44	RESISTOR, 1 KOHM, 1/4W, 5%	303-0102-000	1	R22	AXI	5 BEND
45	RESISTOR, 4.7 KOHM, 1/4W, 5%	303-0472-000	2	R1,R25	AXI	5 BEND
46	RESISTOR, 39 KOHM, 1/4W, 5%	303-0393-000	1	R2	AXI	5 BEND
47	RESISTOR, 1.5 MOHM, 1/4W, 5%	303-0155-000	1	R26	AXI	5 BEND
48						
49						
50						
51						
52	RESISTOR ARRAY, 10 KOHM, SIP	340-4310-103	3	RN3,RN6,RN7	LG	
53						
54						
55						
56						
57						
58						
59						
60	IC, 4-16 DECODER, 74LS154	074-7415-004	2	U1,U2	LG	
61	IC, PIO, Z8420	070-8420-000	2	U5,U6	LG	
62	IC, CTC, Z8430	070-8430-000	1	U4	LG	

SIGNATURES		DATE
DRAWN	B.J. O'HELLA	10-26-90
CHECKED	A.J. YARZEBINSKI	10-29-90
ENGR.	T.H. BRAUNSTEIN	10-29-90
PROJ. MGR.	N/A	

SEE SHT. 1 FOR REV. LEVEL

MEDRAD TECHNOLOGY FOR PEOPLE

TITLE

MK V INJECTOR
I/O BOARD ASSEMBLY

DWG. NUMBER 78101-10-AP-02 REV. W

DATE COPIED

SHEET 2 OF 3

Plot:Mon 3-1-1993

BILL OF MATERIAL

ITEM	DESCRIPTION	PART NUMBER	QTY.	REF. DESIG.	PROCESS CODE	PREP. CODE
63	IC, BUS TRANS, 74LS645	074-74LS-645	1	U22	DIP	
64	IC, BUFFER, 74LS541	074-74LS-541	2	U14,U15	DIP	
65	IC, QUAD NAND GATE, 74LS00	074-74LS-000	1	U10	DIP	
66	IC, D FLIP-FLOP, 74LS175	074-74LS-175	1	U7	DIP	
67	IC, QUAD QC NAND, 7403	074-7403-000	1	U13	DIP	
68	IC, HEX INVERTER, 74PC04	080-74PC-004	1	U25	DIP	
69	IC, OP-AMP, LF412	050-0412-000	1	U26	DIP	
70	IC, D FLIP-FLOP, 74LS74	074-74LS-074	1	U12	DIP	
71	IC, OCTAL D F-F, 74LS273	074-74LS-273	1	U20	DIP	
72	IC, D/A CONV, DAC-08	126-0008-000	1	U21	DIP	
73	IC, HEX BUFFER, 74365	074-7436-005	2	U16,U19	DIP	
74	IC, TIMER, 555	053-0555-050	1	U27	DIP	
75	IC, PROG. LOGIC ARRAY	071-8215-300	1	U8	AW	

ITEM	DESCRIPTION	PART NUMBER	QTY.	REF. DESIG.	PROCESS CODE	PREP. CODE

SIGNATURES		DATE
DRAWN	B.J. O'HELLA	10-26-90
CHECKED	A.J. YARZEBINSKI	10-29-90
ENGR.	T.H. BRAUNSTEIN	10-29-90
PROJ. MGR.	N/A	

SEE SHT. 1 FOR REV. LEVEL

MEDRAD TECHNOLOGY FOR PEOPLE

TITLE

MK V INJECTOR I/O BOARD ASSEMBLY

DWG. NUMBER 78101-10-AP-02 REV. W

DATE COPIED

SHEET 3 OF 3

Plot:Mon 3-1-1993

SECTION 9 - SERVO CONTROL CARD SUMMARY OF OPERATION

Summary of Operation

The Servo Control Card serves two primary functions:

1. Provide signals for the Flow Rate and Power Drive circuits
2. Read and interpret information from the head, to control injection Flow Rate and Pressure [limit].

Refer to the figure on pages 9 - 3 and 9 - 4 for a block diagram of the Servo Control Card.

Bus Buffers

The control bus is buffered by U12, and the address bus is buffered by U11. The bi-directional data bus is buffered and controlled by U10, with direction control coming from direction logic.

Direction Logic

Gates U7-U9 control the direction line of U10, controlling the flow of data to and from the card.

A/D Converter

Analog-to-digital (A/D) converter U1 inputs a multiplexed analog signal, and converts it into a digital word. This process is controlled by the A/D converter logic (U4, U5) and the DAC decoder (U14). When requested from the CPU, the converted 10-bit value is gated to the data bus by tri-state buffers U2 and U3.

A/D Converter Logic

Gates U4 and U5 control the A/D converter U1, starting the A/D conversion when the data is ready, and enabling buffers U2 and U3 to transfer the converted word to the data bus.

DAC Decoder

Decoder U14, with U18 and U6, provide enable signals for the DACs (digital-to-analog converters) and the MUX (multiplexer). These enables allow data bus information to be written to the device. The decoder also provides signals for the A/D converter logic, direction logic, and Reset pulses for WATCHDOG 2.

WATCHDOG 2

The DAC decoder sends pulses to WATCHDOG 2 (U15) when the mechanical stop is in position, and "Ready to Inject". If the Mechanical Stop takes too long to move into position, the pulses from the DAC decoder will stop, resulting in a disarm condition. The Control Panel will then display the message code SC222 *(Mechanical Stop Position Failure).*

PIO3

The inputs to PIO3 (U16) are signals from the Injector Head, Power Drive Circuit, and the analog portion of the SCC. These inputs include: Turret switch position, 60 ml indication, and FWD/REV indication from the Injector Head, Aux Monitor from the PDC, and an Overpressure Limit signal from the SCC. The status of PIO3 inputs are directed to the CPU through data busses. Outputs from PIO3 include: Flow Control signals, the Safe Relay Enable, and the System Override signal.

System Monitor Flip-Flop

The flip-flop (U17) sends alarm signals to disarm the injector, if any of the following input conditions occur: WATCHDOG 2, OPLIM (overpressure signal), or AUX MONITOR (power drive failure).

Servo Control Card

Command, Position, and Signal DACs

When enabled and timed by the DAC decoder U14, one of the DACs U21-U24 will read a byte of data bus information. The DAC then converts the byte to an analog voltage between zero and 10 VDC. DAC resolution is 40mV per count.

Pressure Limit Command DAC

The output of this DAC is the Pressure Limit Command signal (PSILIM SELECTED). This signal is sent to the Multiplexer, the Primary Pressure Limit circuit, and the Overpressure Limit circuit.

Flow Rate Command DAC

The output of this DAC is the Flow Rate Command signal (FLOW RATE SELECTED). This signal is sent to the Multiplexer, Flow Scale Circuit and Power Drive Card (PDC or PDCP).

Mechanical Stop Position DAC

The output of this DAC is the Mechanical Stop Position signal (MSPOSCMD). This signal is sent to the Multiplexer, and through Unity Gain Buffer U26C, to the Mechanical Stop Drive Card.

Velocity Signal DAC

The output of this DAC is a digitized velocity signal, sent to the Imaging System Interface Card. This signal is buffered, becoming the Flow Profile Signal available through connector J15, pin 4.

Multiplexer (MUX)

The multiplexer circuit is comprised of multiplexer U19, Quad latch U20, and Unity-Gain buffer U26A. This circuit receives eight inputs, and under timing control connects each input to the circuit output, which is sent to the A/D converter.

TTL/CMOS Converter

U25 converts TTL logic (0/5V) to CMOS logic (0/15V).

10V Reference

Chip U28 develops +10 VDC as a reference voltage for the Plunger and Mechanical Stop position feedback pots in the head. This voltage is also applied to the multiplexer to be monitored by the CPU.

Pot Processor

This circuit, comprised of U27C and associated components, buffers and filters the pot wiper signal. The pot signal is an input to the multiplexer and the error amplifier.

Primary Pressure Limit Circuit

The Primary pressure limit circuit (U26B), compares the pressure limit command to the actual pressure developed during an injection. The output of this circuit is sent to three Pressure Limiting circuits to perform the following functions:

- Flow Rate Integrator Circuit U29. The output of U26B is summed with the Flow Rate command to effectively reduce the input voltage to U29. This action results in the reduction of the Flow Rate command signal, thereby preventing the selected pressure limit from being exceeded.

- Inverting amplifier, U27B. The output of this amplifier is summed with the output of the Main Flow Integrator, to reduce the voltage sent to the error amplifier U27D, thereby decreasing the error signal.

- Circuit Q4. This circuit is driven to cut-off, sending a pressure limit indication signal (PRESLIMIND) to PIO3 (U16), and eventually to the CPU. This PRESLIMIND signal will also send Q12 into a saturation state, which shunts R81 and reduces the gain of the error amplifier, thereby decreasing the error signal.

Overpressure Circuit

If the actual pressure exceeds the pressure limit command by greater than 100-150 PSI, the Overpresssure Circuit (U26D) forwards an OPLIM signal to stop the injection.

Flow Scale Circuit

Using the two flow scale signals, circuits Q5, Q6, and Q11 attenuate the flow rate selected signal during ML/MIN and ML/HR flow scale injections. (ML/MIN and ML/HR does not apply to MCT units)

Standby Reset Circuit

Driven by the INJECT signal, Q8, Q9, and Q10 control the flow rate integrator, U29. During standby, the integrator follows the position pot. The output of the integrator is equal in amplitude, and opposite in polarity to the position pot. When an injection is to occur, this circuit allows U29 to generate the position command.

Flow Rate Integrator

The master position command is generated by integrator U29. The output of this circuit is a ramp, with a slope proportional to the input signal (flow rate selected).

Error Amplifier

When the plunger is moving at the desired flow rate, the master position command from U29 and the pot wiper signal from U27C are equal but opposite in polarity. The output of error amplifier U27D is the difference between these two signals, or the position error. This error signal is used by the drive circuits to power the motor. If pressure limiting occurs, a signal from U27B reduces the error signal, and the gain of U27D is reduced by Q12.

Feed Forward Circuit

This circuit, comprised of Q7 and U27A, provides a boost voltage to the motor to compensate for the internal resistance of the motor. This turning voltage varies with the Flow Rate.

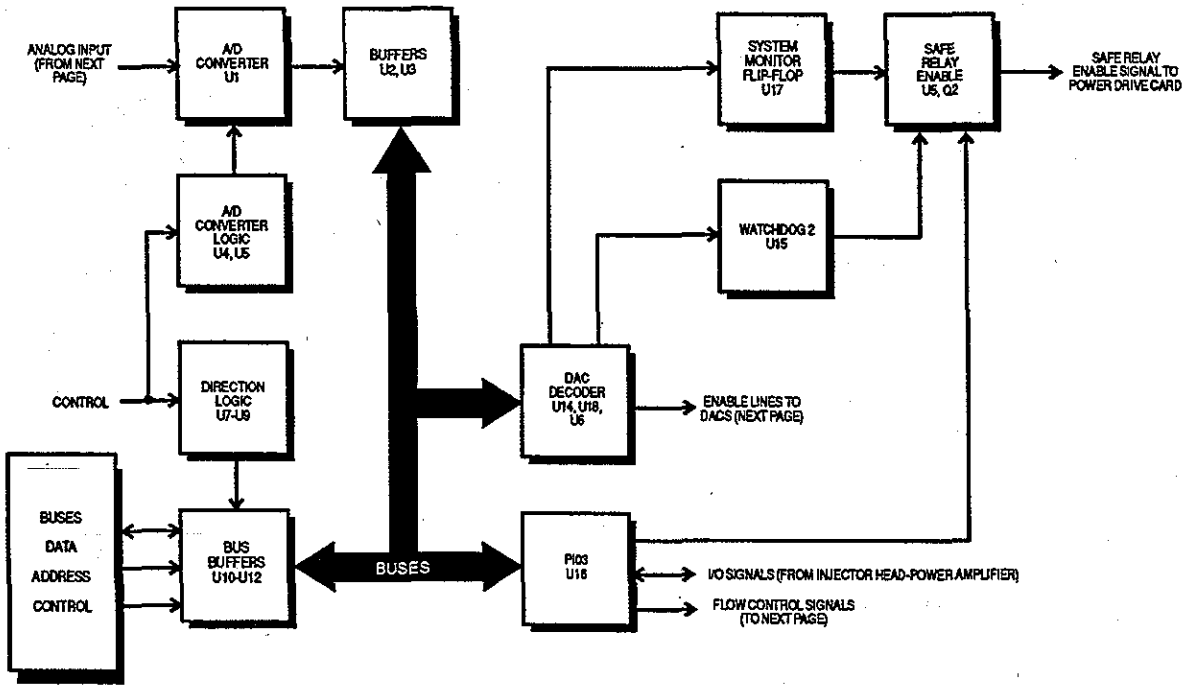


Figure 9.1: Block Diagram: Servo Control Card (sheet 1 of 2)

Servo Control Card

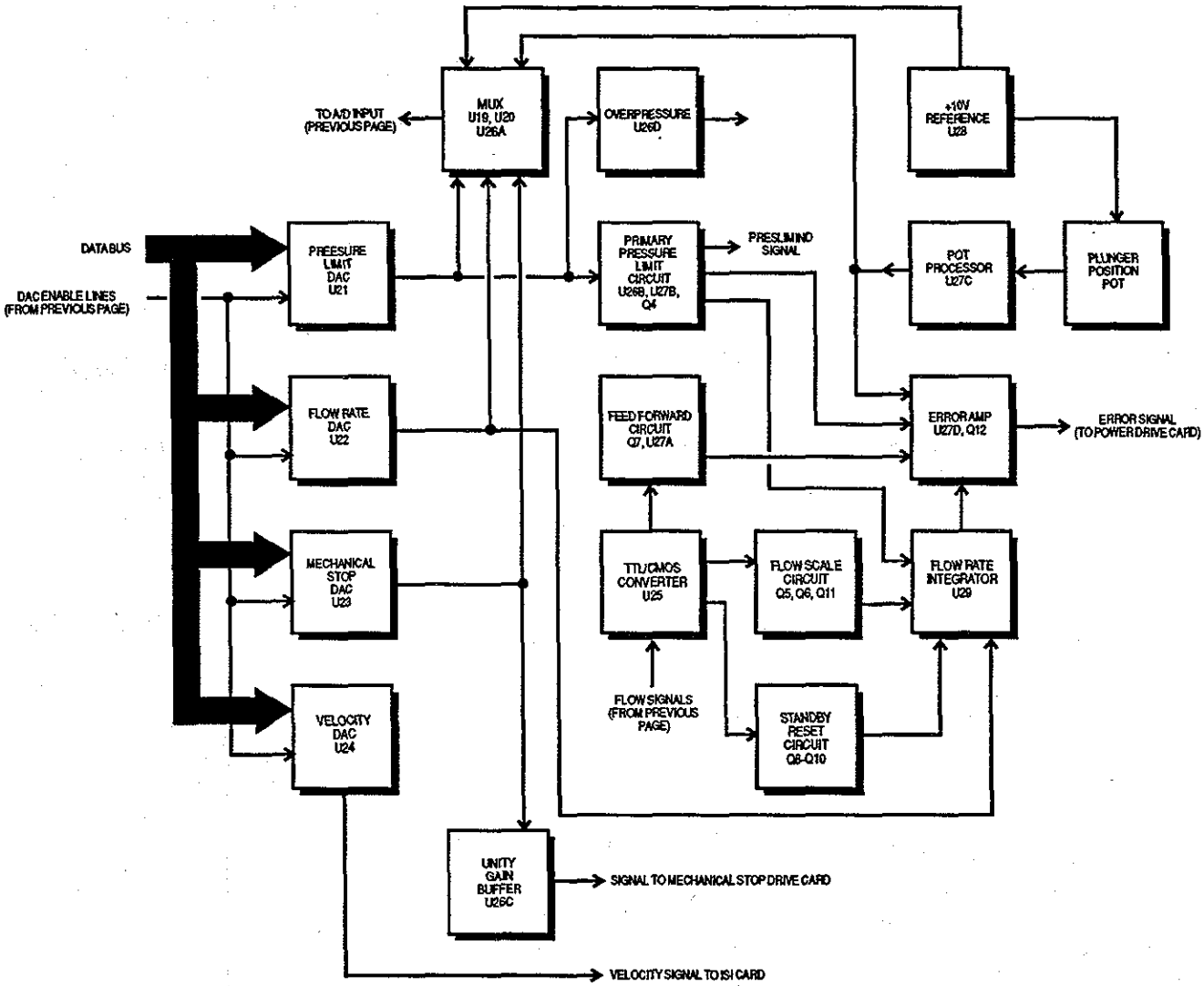
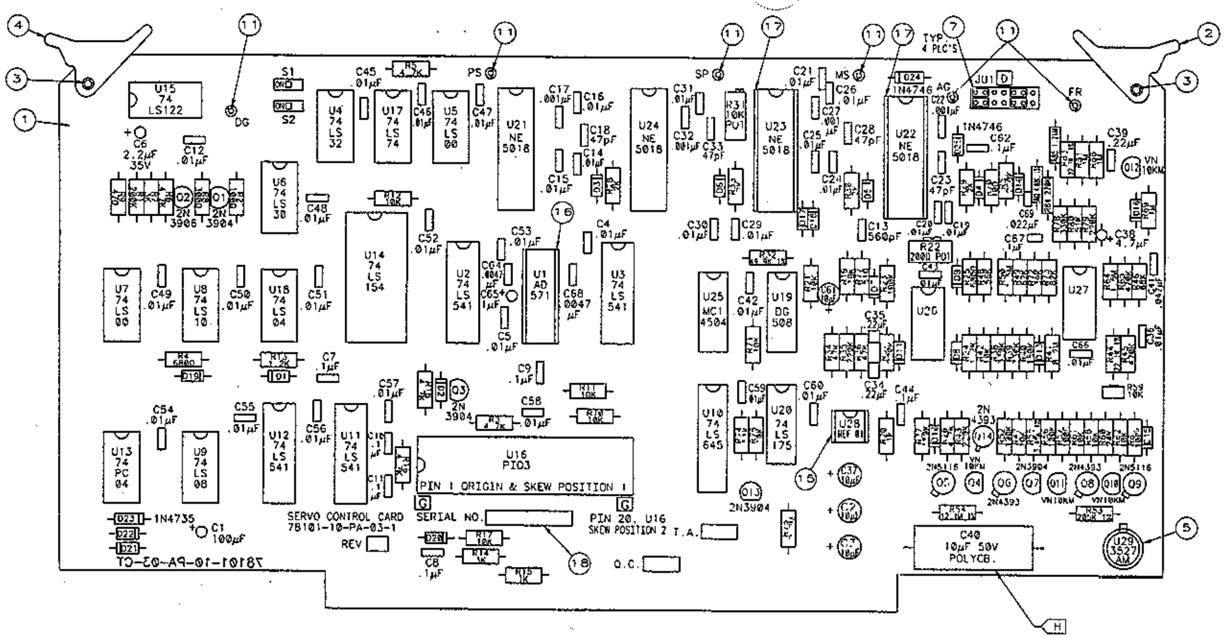


Figure 9.2: Block Diagram: Servo Control Card (sheet 2 of 2)

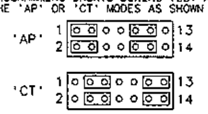
REV	ECO NO.	REVISIONS DESCRIPTION	DATE	APPVD.
GG	EC-631	CLARIFY OR SVC. MANUAL SEE REV. FF FOR PRIOR REVISIONS	3/13/92 TJM	3/18/92 RAK
HH	EC-990	ADDED NOTE H	1/4/93	1-6-93
JJ	EC-1048	ADDED ITEMS 116 & 117. PROCESS CODE CHANGES. IT. 78 QTY. WAS 3. IT. 53 QTY. WAS 6	2-26-93 SCS	DPK



[A] INSTALL COMPONENTS MARKED 'DO NOT WAVE SOLDER' AFTER WAVE SOLDER. HAND CLEAN COMPONENTS MARKED 'DO NOT VAPOR DEGREASE OR WATER WASH'. MASK ALL COMPONENT LOCATIONS MARKED 'DO NOT WAVE SOLDER'

[B] ALL UNMARKED DIODES 1N4148.

[D] INSTALL PROGRAMMING SHUNT (ITEM 7) AS DETAILED ABOVE FOR JUMPER JU1 DURING ASSEMBLY. T/A WILL SET PROGRAMMING SHUNTS DURING TEST AS REQUIRED TO THE 'AP' OR 'CT' MODES AS SHOWN BELOW:



[E] PRODUCTION TO FILL IN REV BLOCK USING PERMANENT INK WITH THE ASSEMBLY DRAWING REVISION TO WHICH THE BOARD WAS BUILT. SERIAL NO. BLOCK TO BE FILLED USING PERMANENT INK OR LABEL (ITEM 18).

[F] ALL SOCKETED COMPONENTS TO BE INSTALLED AFTER WAVE SOLDER.

[G] LOCATIONS MARKED 'G' ARE USED TO INDICATE ORIGIN AND SKEW LOCATIONS.

[H] USE ADHESIVE TO FASTEN C40 TO THE BOARD. USE RTV OR EQUIVALENT REMOVABLE SILICON BASED ADHESIVE.

PROCESS COMPATABILITY CHART

ITEM DESIG.	DO NOT WAVE SOLDER	DO NOT VAPOR DEGREASE	DO NOT WATER WASH
ITEM 2	X		
ITEM 3	X		
ITEM 4	X		
S1,2	X	X	X
U29	X		
C40	X		

9-5

SIGNATURES		DATE
DRAWN	JCB	2/24/84
CHECKED	AJY	7/6/84
ENGR.	JS	7/9/84
	YARZEBINSKI	3/18/92

DO NOT SCALE DRAWING

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MEDRAD INC.
271 KAPPA DRIVE
PITTSBURGH, PA 15238

TITLE: MKV MCT INJECTOR SERVO CONTROL CARD ASSEMBLY

SIZE D | DWG. NUMBER 78101-10-AP-03-1 | REV JJ

SCALE NTS | SHEET 1 OF 3

BILL OF MATERIAL

ITEM	DESCRIPTION	PART NUMBER	QTY.	PROCESS CODE	PREP CODE	REF. DESIG
1	PC CARD (REV L AND UP)	78101-10-PC-03	1	LG		
2	CARD EJECTOR (WHITE)	510-7000-000	1	AW		
3	CARD EJECTOR PIN	510-7001-000	2	AW		
4	CARD EJECTOR (GREEN)	510-7004-000	1	AW		
5	SPACER, IC PAD, 8 PIN	600-0615-075	1	AW		U29
6	SWITCH, SPST	450-4356-651	2	AW		S1,2
7	PROGRAMMING SHUNT	518-5312-202	4	AW		NOTE 8
10	HEADER, 14 PIN	500-1070-700	1	AW		JU1
11	TUBULAR TERMINAL	642-1238-000	6	BW		
15	IC SOCKET, 8 PIN	545-0008-000	1	LG		U28
16	IC SOCKET, 18 PIN	545-8181-018	1	LG		U1
17	IC SOCKET, 22 PIN	545-8221-022	2	LG		U22,23
18	LABEL, BLANK SERIAL NUMBER	550-0093-652	1	BW	NOTE E	
20	CAP, 10uf 50V POLYCARBONATE	209-0106-500	1	AW	14 BEND	C40
21	CAP, 560pF, 50V	201-0561-050	1	LG	.1-LS	C13
22	CAP, .047uf, 50V	201-0473-050	1	LG	.1-LS	C41
23	CAP, .0047uf, 50V	201-0472-050	2	LG	.1-LS	C64,68
24	CAP, .022uf, 50V	201-0223-050	1	LG	.1-LS	C69
25	CAP, 47PF, 50V	201-0470-050	4	LG	.1-LS	C18,23,28,33
26	CAP, .001uf, 50V	201-0102-050	4	LG	.1-LS	C17,22,27,32
27	CAP, .22uF, 50V	201-0224-050	3	LG	.1-LS	C34,35,39
28	CAP, .1uf, 50V	201-0104-050	8	LG	.1-LS	C7,8,9,10,11,44,62,67
29	CAP, .01uf, 50V	201-0103-050	35	LG	.1-LS	C1,5,12,14-16,19-21,24-26,29-31,36,42,43,45-48,66
30	CAP, 2.2uf, 35V	206-0225-350	1	LG	.1-LS	C6
31	CAP, 100uf, 10V	204-0107-010	1	LG	.1-LS	C1
32	CAP, 1uf, 35V	206-0105-350	1	LG	.1-LS	C65
33	CAP, 10uf, 35V	206-0106-351	4	LG	.1-LS	C2,3,37,61
34	CAP, 4.7uf, 35V	206-0475-350	1	LG	.1-LS	C38
40	TRANSISTOR, 2N3904	120-3904-000	4	BW		Q1,3,7,13
41	TRANSISTOR, 2N3906	121-3906-000	1	BW		Q2
42	TRANSISTOR, FET, VN10KM	019-0010-000	4	BW		Q4,10,11,12
43	TRANSISTOR, 2N5116	175-5116-000	2	BW		Q5,9
44	TRANSISTOR, FET, 2N4393	175-4393-000	3	BW		Q6,8,14
45	DIODE, 1N4148	105-4148-000	21	AXI	5 BEND	D1-11,13-22
46	DIODE, ZENER, 1N4735, 6.2V	102-4735-100	1	BW	5 BEND	D23
47	DIODE, ZENER, 1N4746, 18V	102-4746-100	2	BW	5 BEND	D24,D25

ITEM	DESCRIPTION	PART NUMBER	QTY.	PROCESS CODE	PREP CODE	REF. DESIG
50	RESISTOR, 47 OHM 1/4 W 5%	303-0470-000	1	AXI	5 BEND	R9
51	RESISTOR, 200 KOHM 1/4 W 5%	303-0204-000	1	AXI	5 BEND	R1
52	RESISTOR, 3 KOHM 1/4 W 5%	303-0302-000	2	AXI	5 BEND	R7,14
53	RESISTOR, 4.7 KOHM 1/4 W 5%	303-0472-000	5	AXI	5 BEND	R3,5,6,18,26
54	RESISTOR, 300 KOHM 1/4 W 5%	303-0301-000	1	AXI	5 BEND	R8
55	RESISTOR, 100 OHM 1/4 W 5%	303-0101-000	2	AXI	5 BEND	R2,57
56	RESISTOR, 680 OHM 1/4 W 5%	303-0681-000	2	AXI	5 BEND	R4,25
57	RESISTOR, 1.2 KOHM 1/4 W 5%	303-0122-000	2	AXI	5 BEND	R13,24
58	RESISTOR, 10 KOHM 1/4 W 5%	303-0103-000	13	AXI	5 BEND	R10,11,12,17,19,21,42,47,58,61,62,71,76
59	RESISTOR, 1 KOHM 1/4 W 5%	303-0102-000	2	AXI	5 BEND	R15,20
60	RESISTOR, 2 KOHM 1/4 W 5%	303-0202-000	4	AXI	5 BEND	R28,29,30,33
61	RESISTOR, 10 OHM 1/4 W 5%	303-0100-000	1	AXI	5 BEND	R70
62	RESISTOR, 220 KOHM 1/4 W 5%	303-0224-000	5	AXI	5 BEND	R35,37,43,51,79
63	RESISTOR, 100 KOHM 1/4 W 5%	303-0104-000	5	AXI	5 BEND	R23,27,52,56,63
64	RESISTOR, 51 OHM 1/4 W 5%	303-0510-000	1	AXI	5 BEND	R77
65	RESISTOR, 49.9 KOHM 1%	313-4992-000	1	AXI	5 BEND	R32
66	RESISTOR, 4.02 KOHM 1%	313-4021-000	1	AXI	5 BEND	R82
67	RESISTOR, 270 OHM 1/4 W 5%	303-0274-000	1	AXI	5 BEND	R84
68	RESISTOR, 1.21 MOHM 1%	313-1214-000	1	AXI	5 BEND	R85
69	RESISTOR, 22.1 KOHM 1%	313-2212-000	2	AXI	5 BEND	R44,83
70	RESISTOR, 1 MOHM 1/4 W 5%	303-0105-000	2	AXI	5 BEND	R69,81
71	RESISTOR, 51 KOHM 1/4 W 5%	303-0513-000	2	AXI	5 BEND	R74,80
72	RESISTOR, 330 KOHM 1/4 W 5%	303-0334-000	3	AXI	5 BEND	R38,39,78
73	RESISTOR, 150 KOHM 1/4 W 5%	303-0154-000	1	AXI	5 BEND	R40
74	RESISTOR, 8.2 MOHM 1/4 W 5%	303-0825-000	1	AXI	5 BEND	R41
75	RESISTOR, 470 KOHM 1/4 W 5%	303-0474-000	2	AXI	5 BEND	R45,65

SIGNATURES		DATE
DRAWN	WHALEN	9-13-90
CHECKED	A. YARZEBINSKI	9-25-90
ENGR.	T. BRAUNSTEIN	9-26-90
PROJ. MGR.	YARZEBINSKI	3-18-92

SEE SHT. 1 FOR REV. LEVEL

MEDRAD INC.
271 KAPPA DRIVE
PITTSBURGH, PA 15238

TITLE

MARK V INJECTOR SERVO CONTROL CARD ASSEMBLY

DWG. NUMBER 78101-10-AP-03-1 REV. JJ

DATE COPIED

SHEET 2 OF 3

Plot:Mon 3-1-1993

BILL OF MATERIAL

ITEM	DESCRIPTION	PART NUMBER	QTY.	PROCESS CODE	PREP CODE	REF. DESIG
76	RESISTOR, 68 KOHM 1/4 W 5%	303-0683-000	1	AXI	5 BEND	R46
77	RESISTOR, 1.5 MOHM 1/4 W 5%	303-0155-000	2	AXI	5 BEND	R50,64
78	RESISTOR, 82 KOHM 1/4 W 5%	303-0823-000	1	AXI	5 BEND	R73
79	RESISTOR, 39 KOHM 1/4 W 5%	303-0393-000	1	AXI	5 BEND	R72
80	RESISTOR, 62 KOHM 1/4 W 5%	303-0623-000	1	AXI	5 BEND	R49
81	RESISTOR, 56 KOHM 1/4 W 5%	303-0563-000	1	AXI	5 BEND	R48
82	RESISTOR, 47 KOHM 1/4 W 5%	303-0473-000	2	AXI	5 BEND	R34,36
83	RESISTOR, 24 KOHM 1/4 W 5%	303-0243-000	1	AXI	5 BEND	R60
84	RESISTOR, 3.48 KOHM 1%	313-3481-000	1	AXI	5 BEND	R55
85	RESISTOR, 2.2 MOHM 1/4 W 5%	303-0225-000	1	AXI	5 BEND	R75
86	RESISTOR, 12.1 MOHM 1%	315-1215-000	1	AXI	5 BEND	R54
87	RESISTOR, 205 KOHM 1%	313-2053-000	1	AXI	5 BEND	R53
88	POT, 200 OHM 1 TURN	353-0201-010	1	LG		R22
89	POT, 10 KOHM, 25 TURN	362-0103-010	1	LG		R31
90	POT, 10 KOHM 1 TURN	353-0103-010	1	LG		R59
95	IC, A/D CONV, AD571	050-0571-000	1	AW		U1
96	IC, VOLTAGE REF, REF-01	052-4101-000	1	AW		U28
97	IC, PRECISION OP AMP,3527AM	050-3527-070	1	AW		U29
98	IC, MONOSTABLE, 74LS122	074-74LS-122	1	DIP		U15
99	IC, QUAD OR GATE, 74LS32	074-74LS-032	1	DIP		U4
100	IC, D FLIP-FLOP, 74LS74	074-74LS-074	1	DIP		U17
101	IC, QUAD NAND GATE, 74LS00	074-74LS-000	2	DIP		U5,7
102	IC, D/A CONV, NE5018	053-5018-000	2	AW		U22,23
102	IC, D/A CONV, NE5018	053-5018-000	2	DIP		U21,24
103	IC, 8-INPUT NAND, 74LS30	074-74LS-030	1	DIP		U6
104	IC, 3-INPUT NAND, 74LS10	074-74LS-010	1	DIP		U8
105	IC, HEX INVERTER, 74LS04	074-74LS-004	1	DIP		U18
106	IC, 4-16 DECODER, 74LS154	074-74LS-154	1	LG		U14
107	IC, BUFFER, 74LS541	074-74LS-541	4	DIP		U2,3,11,12
108	IC, LEVEL SHIFTER, MC14504B	004-4504-000	1	DIP		U25
109	IC, ANALOG SWITCH, DG508	051-0508-000	1	DIP		U19
110	IC, QUAD OP AMP	060-4741-500	2	DIP		U26,27
111	IC, HEX INVERTER, 74PC04	080-74PC-004	1	DIP		U13
112	IC, QUAD 2 INPUT AND, 74LS08	074-74LS-008	1	DIP		U9
113	IC, PIO, Z8420	070-8420-000	1	LG		U16
114	IC, BUS TRANS, 74LS645	074-74LS-645	1	DIP		U10

ITEM	DESCRIPTION	PART NUMBER	QTY.	PROCESS CODE	PREP CODE	REF. DESIG
115	IC, D FLIP-FLOP, 74LS175	074-74LS-175	1	DIP		U20
116	RESISTOR, 4.7KΩ, 1/4W, 5%	303-0472-000	1	LG	5 BEND	R16
117	RESISTOR, 1MΩ, 1/4W, 5%	303-0105-000	1	LG	5 BEND	R66

SIGNATURES		DATE
DRAWN	WHALEN	9-13-90
CHECKED	A. YARZEBINSKI	9-25-90
ENGR.	T. BRAUNSTEIN	9-26-90
PROJ. MGR.	YARZEBINSKI	3-18-92

SEE SHT. 1 FOR REV. LEVEL

MEDRAD INC.
271 KAPPA DRIVE
PITTSBURGH, PA 15238

TITLE

MARK V INJECTOR SERVO CONTROL CARD ASSEMBLY

DWG. NUMBER 78101-10-AP-03-1 REV. JJ

DATE COPIED

SHEET 3 OF 3

Plot:Mon 3-1-1993

SECTION 10 - PPI CARD SUMMARY OF OPERATION

There are two versions of the PPI Card, identified by the card revision level and serial number. Use the chart below to identify card type, then refer to the appropriate description on the following pages.

Revision	Serial Number	PPI Card Type
Revision B	20000 - 25665	Type B
Revision C and above	25666 and Above	Type C

PPI Card Type B (serial numbers 20000 to 25665)

For a block diagram of PPI Card type B, refer to page 10 - 3.

Bus Buffers

The control bus is buffered by U3, and the address bus is buffered by U1 and U2. The bidirectional data bus is buffered by U4 and U5, with direction defined by one of the lines on the control bus. These data buffers are enabled by the decoder. The data bus for the primary memory chip is controlled by U5; the backup memory chip data bus is controlled by U4.

Decoder

Decoder U6 provides the enable lines for the data bus buffers, the memory chips, and the RS-232C circuit.

PPI Memory

Primary PPI memory is provided by 8K RAM chip U9. Backup PPI memory is provided by U8. The chips are enabled by signals from the decoder, while outputs are enabled by lines from the control bus.

Memory Comparator

The data buses from the primary and backup memory are continuously compared by U7. If the values do not agree, latch U11 sends a signal (MEMERRINT), enabling the CTC on the I/O Card, to interrupt the processor.

Analog Switches

The enable lines for the memory chips are switched through U16. When power is applied, the switches are closed, connecting the enable lines. When power is removed or low, the switches are open, disabling the enable lines to preserve power.

Power-Down and Battery Circuit

When power is removed, or is low, Q1- Q3 disables U16 and opens the analog switches to disable the memory chips to conserve power as they switch over to battery power. The battery provides backup power for the memory chips to preserve the contents when power is removed.

RS-232C Circuit

This circuit consists of Universal Asynchronous Receiver/Transmitter (UART) U13, baud rate clock U12, line receivers U15, and line driver U14. With this circuit, the Main Unit can communicate with the Remote Panel using an RS-232C serial interface.

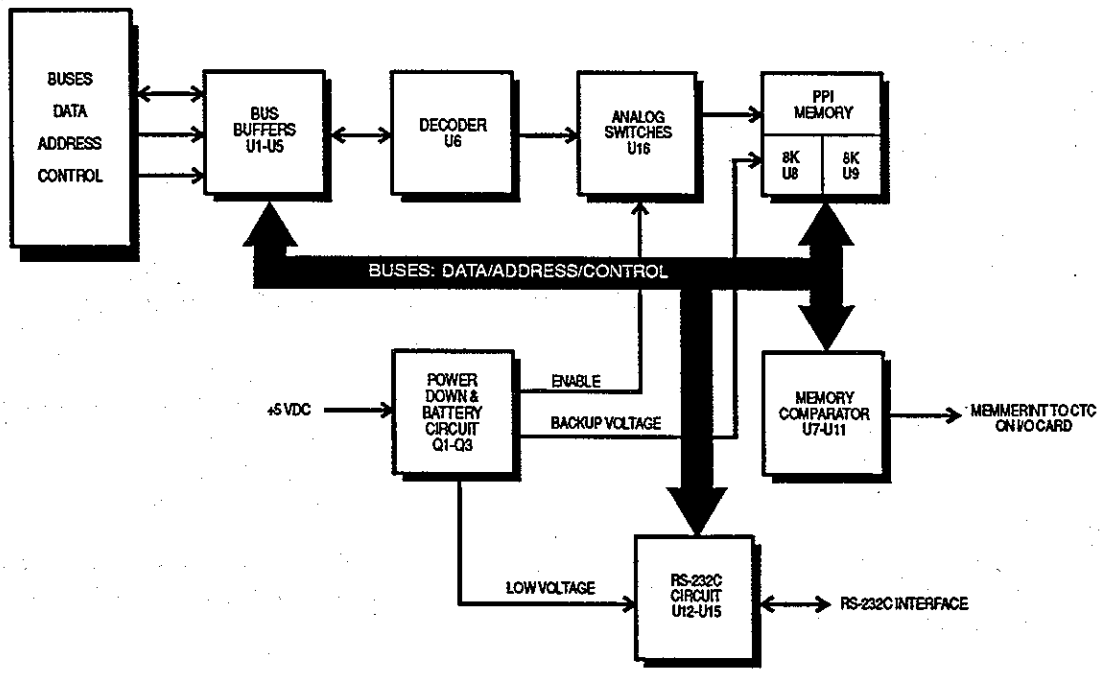


Figure 10.1: Block Diagram: PPI Card Type B

PPI Card Type C (serial number 25666 and above)

For a block diagram of PPI Card type C, refer to page 10 - 5.

Bus Buffers

The control bus is buffered by U3, and the address bus is buffered by U1 and U2. The bidirectional data bus is buffered by U4 and U5, with direction defined by one of the lines on the control bus. These data buffers are enabled by the decoder. The data bus for the primary memory chip is controlled by U5; the backup memory chip data bus is controlled by U4.

Decoder

Decoder U6 provides the enable lines for the data bus buffers, the memory chips, and the RS-232C circuit.

PPI Memory

Primary PPI memory is provided by 8K RAM chip U9. Backup PPI memory is provided by U8. The chips are enabled by signals from the decoder, while outputs are enabled by lines from the control bus.

Memory Comparator

The data buses from the primary and backup memory are continuously compared by U7. If the values do not agree, latch U11 sends a signal (MEMERRINT), enabling the CTC on the I/O Card, to interrupt the processor.

Analog Switches

The enable lines for the memory chips are switched through U16. When power is applied, the switches are closed, connecting the enable lines. When power is removed or low, the switches are open, disabling the enable lines to preserve power.

Power-Down and Battery Circuit

When power is removed, or is low, Q1-Q3 disables U16 and opens the analog switches to disable the memory chips to conserve power as they switch over to battery power. The battery provides backup power for the memory chips to preserve the contents when power is removed.

RS-232C Circuit

This circuit consists of Universal Asynchronous Receiver/Transmitter (UART) U13, baud rate clock U12, U19 RS-232 line driver and receiver, and ferrite beads FB1-FB5 added for reduction of conducted noise. With this circuit, the Main Unit can communicate with the Remote Panel using an RS-232C serial interface.

Ferrite Beads

FB1-FB5 are used to suppress noise from the power source.

NOTE: *Clearing of PPI Memory:*

Type C PPI Cards contain a new feature for the simplification of clearing PPI memory. This can be accomplished by removing power, then shorting pin 2 to pin 1 or 3 of JU1. The shorted state should be maintained for several seconds to ensure complete and proper clearing.

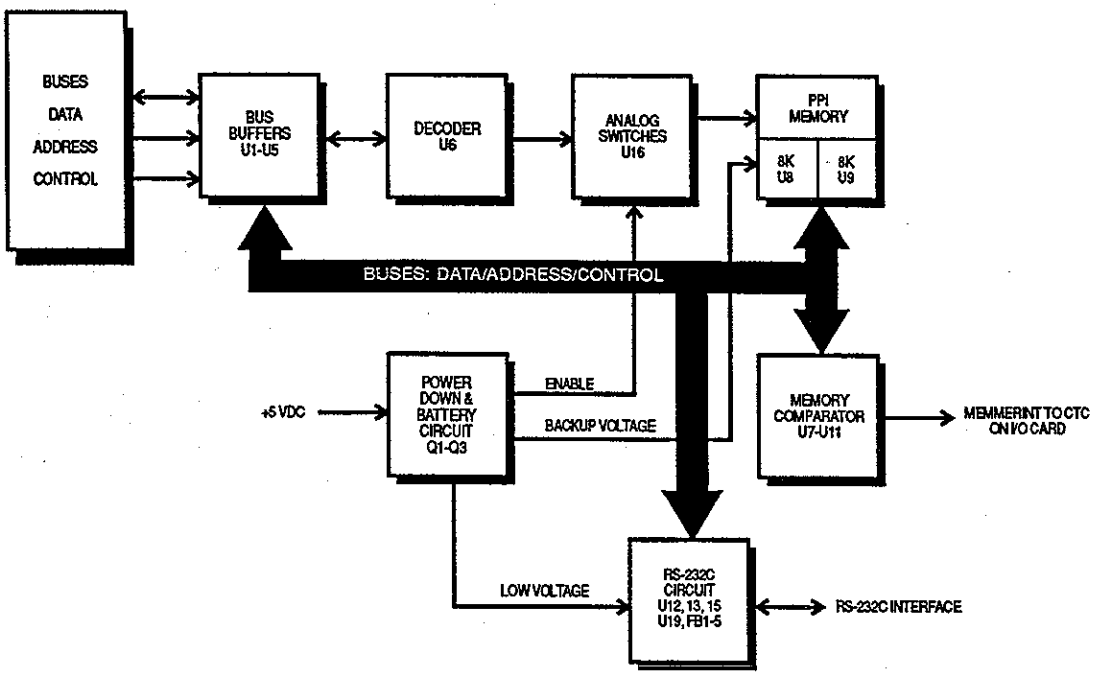
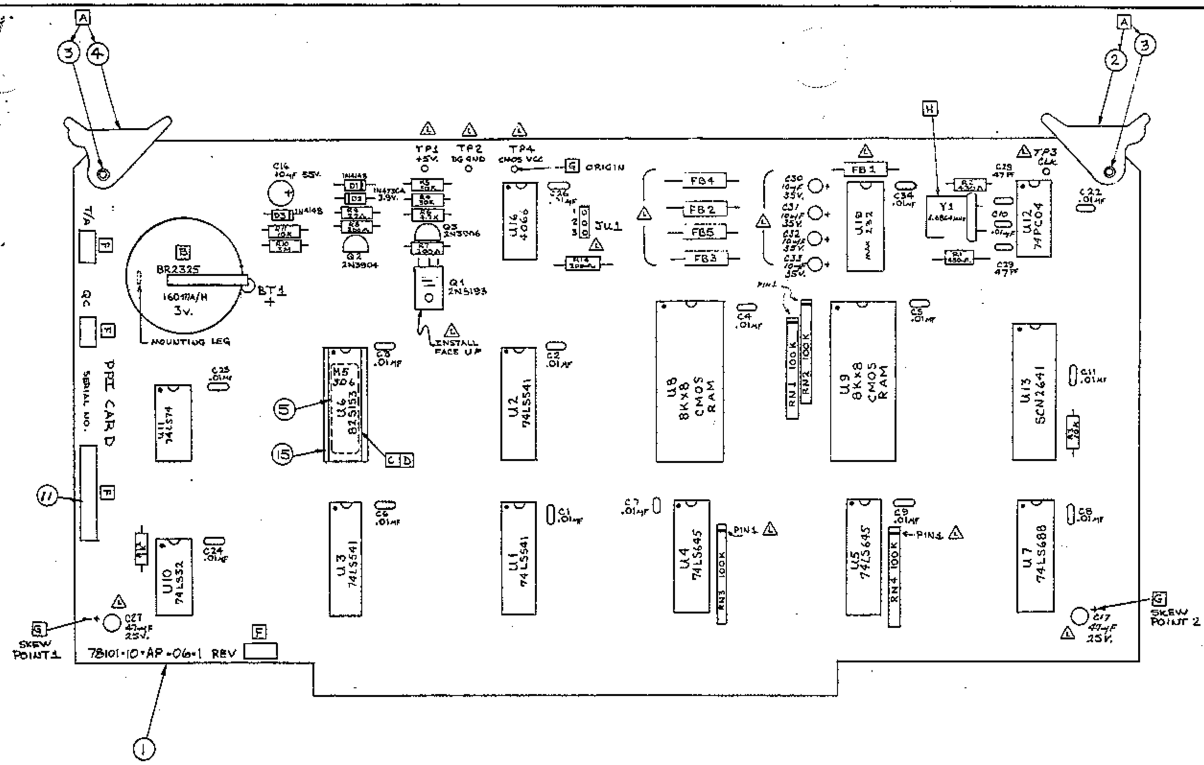


Figure 10.2: Block Diagram: PPI Card Type C

Notes:



NOTES:

A. INSTALL ITEMS 2,3 & 4 AFTER WAVE SOLDER

B. BATTERY (BT1) NOT TO BE INSTALLED UNTIL ALL ELECTRICAL CHECK-OUT PROCEDURES FOR THIS CARD ASSY. HAVE BEEN COMPLETED. BATTERY IS NOT TO BE HANDELED WITH METAL OBJECTS AND ARE TO BE STORED IN SUCH A MANNER TO PREVENT BATTERY ASSY. FROM TOUCHING EACH OTHER, WHICH WILL GUARD AGINST ACCIDENTAL PREMATURE DISCHARGE. DO NOT WAVE SOLDER BATTERY. HAND SOLDER 5 SECONDS MAX.

C. U6 MUST BE PROGRAMMED PRIOR TO INSTALLATION REF DOCUMENT NO. 89064-00-PK-01 FOR PROGRAMMING INSTRUCTIONS. UNPROGRAMMED P/N IS 091-8215-300. PAL LABELS ARE TO BE ATTACHED AFTER PROGRAMMING.

D. REFER TO DOCUMENT NO. 78101-10-SP-04 FOR MASTER DEVICE PROGRAMMING INSTRUCTIONS FOR U6. THIS DOCUMENT FOR ENGINEERING USE ONLY.

E.

PROCESS COMPATABILITY CHART			
ITEM/ DESIG.	DO NOT WAVE SOLDER	DO NOT VAPOR DEGREASE	DO NOT WATER WASH
BT1	X	X	X
2	X		
3	X		
4	X		

ALL COMPONENTS MARKED 'DO NOT WAVE SOLDER' TO HAVE THEIR LOCATIONS MASKED PRIOR TO WAVE SOLDER AND BE INSTALLED AFTER WAVE SOLDER. ALL SOCKETED COMPONENTS TO BE INSTALLED AFTER WAVE SOLDER.

F. PRODUCTION TO COMPLETE SERIAL NO. & REV. BLOCKS USING PRE-PRINTED LABEL (ITEM 11) OR PERMANENT INK. T/A & Q.C. SHOULD INITIAL RESPECTIVE BLOCKS AFTER T/A TEST & Q.C. INSPECTIONS.

G. LIGHT GUIDED INSERTION ORIGIN LOCATION IS TP4. LIGHT GUIDED SKEW POINTS ARE: C27 '+' SIDE-SKEW POINT 1, C17 '+' SIDE-SKEW POINT 2.

H. USE ADHESIVE TO FASTEN Y1 TO THE BOARD. USE RTV OR EQUIVALENT REMOVABLE SILICON BASED ADHESIVE.

SYM	DESCRIPTION	EFFECTIVITY	ENTERED	CHECKED
N	EC-1048, PROCESS CODE CHANGES		[illegible]	[illegible]
M	EC-990, ADDED NOTE 'H'		1-5-93	[illegible]
L	EC 114, REVISED FOR BOARD RE-LAY-OUT, ADDED SH. 2		[illegible] JCB	[illegible]
K	[illegible], RE-ORIENT [illegible]		[illegible] JCB	[illegible]
J	[illegible]		6-15-90 JCB	[illegible]
I	[illegible]	IN-LINE	[illegible] JCB	[illegible]
H	[illegible]	IN LINE	[illegible] JCB	[illegible]
G	[illegible]	[illegible] IN LINE	11-3-87 JCB	[illegible]
F	[illegible]	IN LINE	5-2-[illegible] JCB	[illegible]
E	DCN 384, REVISED NOTE A & C, ADDED [illegible]	IN-LINE	11-18-86 WAK.	[illegible]
D	[illegible]	IN LINE, AS REQ.	[illegible] JCB	[illegible]
C	[illegible]	N/A, ENG. DEPART-MENT ONLY	[illegible] JCB	[illegible]
B	DCN-112, ADDED [illegible]	ALL REV. D CARDS	T.L.	[illegible]
A	DCN [illegible], ADDED [illegible] 303-6103-000	ALL REV. C CARDS	T.L.	[illegible]

REVISION RECORD

MEDRAD TECHNOLOGY FOR PEOPLE

TITLE: MK V INJECTOR - PPI CARD ASSY.

DRAWN BY	DATE	NUMBER	REV
LANE	7-8-85	78101-10-AP-06-1	[illegible]
CHECKED BY [signature]	DATE 10/[illegible]/85	SHEET 1 OF 2	
APPROVED BY [signature]	DATE [illegible]	DATE COPIED	

LAST DESIG. USED - BT1, C27, D3, Q3, R12, RN4, U18, Y1.

BILL OF MATERIAL

ITEM	DESCRIPTION	PART NUMBER	QTY.	PROCESS CODE	PREP CODE	REF. DESIG
1	PC CARD, (REV E AND UP)	78107-10-PC-06	1	LG		
2	CARD EJECTOR (WHITE)	510-7000-000	1	AW		
3	CARD EJECTOR PIN	510-7001-000	2	AW		
4	CARD EJECTOR, (YELLOW)	510-7002-000	1	AW		
5	LABEL, BLANK PAL	550-0017-619	1	AW	NOTE C	U6
6	BATTERY, BR2325-1HB	497-2325-100	1	AW		BT1
10	PIN HEADER, 3 POSITION	518-8001-003	1	BW		JU1
11	LABEL, BLANK SERIAL NUMBER	550-0093-652	1	BW		
12	TUBULAR TERMINAL	642-1238-000	4	BW		TP1-TP4
15	IC SOCKET, 20 PIN	545-8201-020	1	LG		U6
20	CAP, 10UF, 35V	204-0106-135	5	LG	.1-LS	C16,C30-C33
21	CAP, 47UF, 25V	204-0476-025	2	LG	.1-LS	C17,C27
22	CAP, .01UF, 50V	201-0103-050	16	LG	.1-LS	C1-C11,C22,C24-C26,C34
23	CAP, CERAMIC, 47PF	201-0470-050	2	LG	.1-LS	C28,C29
25	CRYSTAL, 3.6864 MHZ	180-0037-000	1	LG		Y1
26	FERRITE BEAD	280-1625-000	5	LG	6 BEND	FB1-FB5
30	TRANSISTOR, 2N5193	125-5193-000	1	BW		Q1
31	TRANSISTOR, 2N3904	120-3904-000	1	BW		Q2
32	TRANSISTOR, 2N3906	121-3906-000	1	BW		Q3
35	DIODE, 1N4148	105-4148-000	2	AXI	5 BEND	D1,D3
36	DIODE, 1N4730A, 3.9V	102-4730-050	1	AXI	5 BEND	D2
40	RESISTOR, 10 KOHM, 1/4 W 5%	303-0103-000	2	AXI	5 BEND	R3,R11
41	RESISTOR, 430 OHM, 1/4 W 5%	303-0431-000	2	AXI	5 BEND	R1,R2
42	RESISTOR, 30 KOHM, 1/4 W 5%	303-0303-000	2	AXI	5 BEND	R4,R5
43	RESISTOR, 4.7 KOHM, 1/4 W 5%	303-0472-000	1	AXI	5 BEND	R6
44	RESISTOR, 200 OHM, 1/4 W 5%	303-0201-000	3	AXI	5 BEND	R7,R8,R14
45	RESISTOR, 27 OHM, 1/4 W 5%	303-0270-000	1	AXI	5 BEND	R9
46	RESISTOR, 3 MOHM, 1/4 W 5%	303-0305-000	1	AXI	5 BEND	R10
47	RESISTOR, 1 KOHM, 1/4 W 5%	303-0102-000	1	AXI	5 BEND	R12
50	RESISTOR ARRAY, 100 KOHM SIP	340-4310-104	4	LG		RN1-RN4
60	IC, D FLIP-FLOP, 74LS74	074-74LS-074	1	DIP		U11
61	IC, QUAD 2-INPUT OR 74LS32	074-74LS-032	1	DIP		U10
62	IC, BUFFER, 74LS541	074-74LS-541	3	DIP		U1,U2,U3
63	IC, QUAD ANALOG SWITCH, 4066	004-4066-000	1	DIP		U16
64	IC, CMOS RAM, TC5564-PL15	071-5564-015	2	LG		U8,U9
65	IC, BUS TRANS, 74LS645	074-74LS-645	2	DIP		U4,U5
66	IC, RS232, MAX232	051-0232-000	1	DIP		U19
67	IC, HEX INVERTER, 74PC04	080-74PC-004	1	DIP		U12
68	IC, UART, SCN2641	051-2641-100	1	LG		U13
69	IC, COMPARATOR, 74LS688	074-74LS-688	1	DIP		U7
70	IC, PROG. LOGIC ARRAY	071-8215-300	1	AW	NOTE C	U6

SIGNATURES		DATE
DRAWN	MAIESE	3/11/91
CHECKED	KISTE	3/12/91
ENGR.		
PROJ. MGR.		

SEE SHT. 1 FOR REV. LEVEL

MEDRAD INC.
271 KAPPA DRIVE
PITTSBURGH, PA 15238

TITLE
MKV INJECTOR - PPI CARD ASSEMBLY

DWG. NUMBER 78101-10-AP-06-1 REV. N

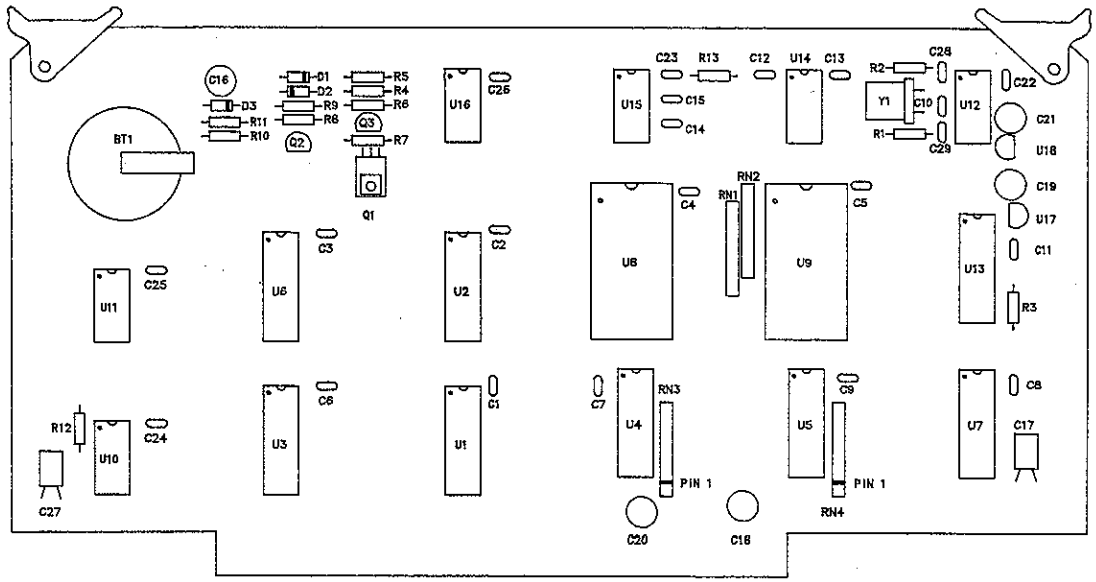
DATE COPIED

SHEET 2 OF 2

Plot:Mon 3-1-1993

161242

REVISIONS				
REV	ECO NO.	DESCRIPTION	DATE	APPVD.



PARTS/MATERIAL LIST				
REF DESIG	DESCRIPTION	PART NUMBER	MATL	QTY.
R13	10K 5% 1/4 w	303-0103-000		1
U14	MC1488P	051-1488-000		1
U15	MC1489AN	051-1489-000		1
C18,C19				
C20,C21	10 ufd 35 V	206-0106-350		4
U17	78L12A or PC	052-7812-200		1
U18	79L12A or ACP or CP	052-7912-200		1
C12,C13				
C23	0.01 ufd 100 V	201-0103-100		3
C14,C15	200 pf	201-0201-000		2

Unless otherwise noted, this assembly applicable to boards rev D and below.

GEOMETRIC TOLERANCES	
SYMBOL	CHARACTERISTIC

STANDARD SYMBOLOGY
- Ø DIAMETER
- (XX) REF. DIM.
- DIM. ORIGIN
- CONICAL TAPER
- SLOPE
- C'BORE
- C'SINK
- DEPTH/DEEP
- XX DIM. NOT TO SCALE

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON:
2 PL DECIMALS ± .01
3 PL DECIMALS ± .005
FRACTIONS 0"-6" ± 1/32
FRACTIONS 6"-UP ± 1/16
ANGULAR ± 0.5°
MAX. SURFACE TEXTURE 125

SIGNATURES	DATE
DRAWN	
CHECKED	
ENGR.	
PROJ. MGR.	

DO NOT SCALE DRAWING

MEDRAD TECHNOLOGY FOR PEOPLE®

TITLE
REVISION HISTORY PPI CARD, 20K SERIES

SIZE	DWG. NUMBER	REV
B	78101-10-RH-01	
SCALE NTS	DATE COPIED	SHEET 1 OF 2

89080

10-9156 CRYSTALENE. A&B SMITH CO., PGH., PA DP 1831-1290

161242

REVISIONS				
REV	ECO NO.	DESCRIPTION	DATE	APPVD.

C.R. 78101-10-29. Update artwork negative and assembly drawings to reflect modifications made during the ECG/Scope pilot run. DDN-112. 78101-10-AP-06-1 no rev. to A. 78101-10-PA-06 rev C to D. 78101-10-PD-06 rev E to F.

C.R. 78101-10-32. Added R13, a pull up resistor that allows the PPI card to function properly with a Remote Panel. All cards rev C and up. DDN-115. 78101-10-SE-06 rev D to E.

C.R. 78101-10-42. Drawing corrections only: C14 and C15 were changed from 220 pf to 200 pf and C17 and C27 were changed from 35 V to 20 V as shown in BOM. DDN-147. 78101-10-AP-06-1 rev B to C.

C.R. 78101-10-55. There were 2 part numbers for MC1488. Change 015-1488-000 to 051-1488-000. DDN-234. 78101-10-AP-06-1 rev C to D.

C.R. 78101-10-73. Production related changes. Revise assembly not to install card ejectors and retaining pins after wave soldering. Add PAL labels (item 7) to BOM. Revise note C to reference document 78101-10-PX-02 for programming procedures. DDN-384. 78101-10-AP-06-1 rev D to E.

C.R. 78101-10-90. Revise note C document reference from 78101-10-PX-02 to 78101-00-PX-02. DDN-459. 78101-10-AP-06-1 rev E to F.

C.R. 78101-10-102. Change U1 pin 19 to pin 15. DDN-524. 78101-10-SE-06 rev E to F.

C.R. 10000-NS-358. Revise note C document reference from 78101-00-PX-02 to 89064-00-PX-01. Add note D. C1 through C13, C22, C23 through C26 were changed from 201-0103-050 (0.1" LS) to 201-0103-100 (0.2" LS). DDN-532. 78101-10-AP-06-1 rev F to G.

C.R. 78101-10-105. Change C10 from 201-0103-100 to 201-0103-050 because hole spacing is incorrect. DDN-556. 78101-10-AP-06-1 rev G to H.

C.R. 10000-NS-420. Change C18 through C21 from 206-0106-200 to 206-0106-350. This increased the voltage rating from 20 V to 35 V. DDN-605. 78101-10-AP-06-1 rev H to I. 78101-10-SE-06 rev F to G.

C.R. 78101-10-115. Added blank label (item 8) and note E. Change voltage ratings of C16, C17, and C27 from 20 V to 35 V, 25 V, and 25 V respectively. Change C28 and C29 from 50 pf to 47 pf. DDN-676. 78101-10-AP-06-1 rev I to J. 78101-10-SE-06 rev G to H.

C.R. 78101-10-123. C17 and C27 were mounted upright. Change orientation so capacitors lay down flat. 78101-10-AP-06-1 rev J to K. DDN-723.

EC-24. U2 had an extra pin 17 that was changed to pin 12. 78101-10-SE-06 rev H to I.

EC-114. PPI card has been relayed out with significant changes. The following components have been deleted on rev E board: R13, U14, U15, C18, C19, C20, C21, U17, U18, C12, C13, C23, C14, C15. The following components have been added: JU1, U19, TP1 through TP4, FB1 through FB5, C30 through C33, and R14. RN3 and RN4 were previously oriented with pin 1 toward the card edge. RN3 and RN4 are rotated 180 degrees on boards rev E and up. Q1 was installed face down. On rev E boards and up Q1 will be installed face up. C17 and C27 were mounted flat. Change orientation so capacitors are upright. Rotate C10, C28, and C29 90 degrees. Change C16 from a 100 ufd to 10 ufd. Added notes F and G. 78101-10-AP-06-1 rev K to L. 78101-10-SE-06 rev I to J. Add note 3 to show schematic of boards rev D and below.

GEOMETRIC TOLERANCES	
SYMBOL	CHARACTERISTIC

STANDARD SYMBOLOGY	
Ø	DIAMETER
(XX)	REF. DIM.
	DIM. ORIGIN
	CONICAL TAPER
	SLOPE
	C'BORE
	C'SINK
	DEPTH/DEEP
XX	DIM. NOT TO SCALE

UNLESS OTHERWISE SPECIFIED	
DIMENSIONS ARE IN INCHES	
TOLERANCES ON:	
2 PL DECIMALS	± .01
3 PL DECIMALS	± .005
FRACTIONS 0"-6"	± 1/32
FRACTIONS 6"-UP	± 1/16
ANGULAR	± 0.5°
MAX. SURFACE TEXTURE	125/

SIGNATURES	DATE
DRAWN	
CHECKED	
ENGR.	
PROJ. MGR.	

DO NOT SCALE DRAWING

MEDRAD TECHNOLOGY FOR PEOPLE®

TITLE

REVISION HISTORY PPI CARD, 20K SERIES

SIZE	DWG. NUMBER	REV
B	78101-10-RH-01	

SCALE NTS | DATE COPIED | SHEET 2 OF 2

89080

10-9156 CRYSTALENE. A&B SMITH CO., PGH., PA DP 1831-1290

SECTION 11 - CONTROL PANEL SUMMARY OF OPERATION

Control Panel Summary of Operation

The Control panel is comprised of the keyboard overlay attached to the Display Card. Refer to page 11 - 2 for a block diagram of the Control Panel cards.

Keyboard Overlay

The keyboard overlay contains rubber membrane keys, interconnected in a matrix of four columns and five rows. This matrix is connected to the Display Card, then to the I/O Card, where PIO2 senses key closures for the system.

Display Card

The Display Card contains the numeric displays and LEDs that show through the keyboard overlay. These devices convey messages and operating status to the operator.

Numeric Display Drivers and Numeric Displays

Three display groups are used to display injection parameters on the Control Panel. Each display group consists of a display driver (U1, U2, or U3), and numeric display units. Display drivers also receive the data and control line information from the I/O Card. Group designations are as follows:

- Display Driver U1, displays Volume Remaining (DS1 - DS3), First Phase Flow Rate (DS6 - DS7), and Scan Delay (DS4, DS5).
- Display Driver U2, displays First Phase Volume (DS8 - DS10), Second Phase Flow Rate (DS11, DS12), and Second Phase Volume (DS13 - DS15).
- Display Driver U3, displays Volume Delivered (DS16 - DS18), and Injection Duration (DS19 - DS22).

LED Driver and LEDs

The remainder of the circuit on the display card controls and drives the LEDs used as indicators and that backlight various words printed on the Control Panel. Display driver U4 and buffer U5 control all LEDs (LP1-LP15), receiving data and control line information from the I/O Card. U4 and U5 control the displays: First Phase, Second Phase, Insufficient Volume, Phase 1, Phase 2, Single Arm, Multi Arm, Armed, and Program Levels 1-6.

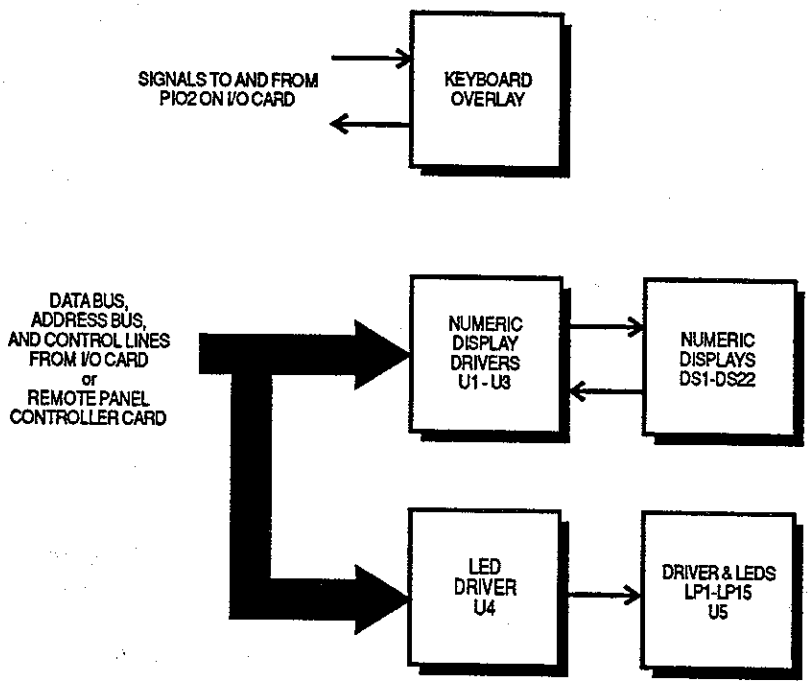


Figure 11.1: Block Diagram: Control Panel